Appendix 1B

Supporting review documents from FofFP

Big Sky Acoustics noise report

big sky acoustics

Assessment of noise impact at residential properties
Wireless Festival 2017

Prepared by: Richard Vivian, Big Sky Acoustics Ltd
On behalf of: The Friends Of Finsbury Park
Document Ref: 17100745

Big Sky Acoustics document control sheet

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Contents

1.0 Qualifications and experience

1.1 My name is Richard Vivian. I am the founder and Managing Director of Big Sky Acoustics Ltd. Big Sky Acoustics is an independent acoustic consultancy that is engaged by local authorities, private companies, public companies and individuals to provide advice on the assessment and control of noise.

1.2 I have a Bachelor of Engineering Degree with Honours from Kingston University, I am a Member of the Institution of Engineering & Technology, the Institute of Acoustics, the Audio Engineering Society and the Institute of Licensing.

1.3 Throughout my career I have worked with high-power professional PA systems. My career started as a research and development engineer for a manufacturer of professional loudspeaker systems used in large concerts and festivals worldwide. I then progressed to senior roles in engineering and product management. In 2002 I established Big Sky Acoustics as an acoustic consultancy specialising in music and entertainment noise assessment and control.

1.4 I have designed and commissioned sound systems across the globe and have an extensive knowledge of the configuration and control of large-scale PA equipment. I have a detailed knowledge and experience of mixing music in recording studios and at live events. I have over thirty years of relevant experience and I have been involved in acoustic measurement and assessment, specifically of noise from amplified music sources, throughout my career.

2.0 Introduction

2.1 Big Sky Acoustics Ltd was instructed by Mr Tom Palin of The Friends Of Finsbury Park (FOFP) to carry out an assessment of the impact of noise from Wireless Festival 2017 on nearby residential properties. FOFP is a registered charity.

2.2 There have been significant numbers of complaints about noise from this festival since 2014. This report was prepared following my site visit and inspection of Finsbury Park, and monitoring of noise levels during the festival in the surrounding residential area.

2.3 A glossary of acoustical terms used in this report is provided in Appendix A.

2.4 All sound pressure levels in this report are given in dB re: 20µPa.

3.0 Site and surrounding area

3.1 The location of the site is shown in Figure 1.

3.2 Finsbury Park ("The Park") is a public park of 46 hectares (110 acres). The Park has a mix of open ground, formal gardens, avenues of mature trees and an arboretum. There is a lake, a children's play area, a café and an art exhibition space. Sports facilities in the Park include football pitches, a bowling green, a skatepark, an athletics stadium, tennis and basketball courts.

3.3 The noise climate in the area surrounding the Park is characterised by road traffic noise on busy roads including Green Lanes to the east and Seven Sisters Road to the south. Away from the main roads background levels are lower in the predominantly residential areas that do not have through traffic.

3.4 For the purpose of this assessment a monitoring position was selected on the balcony of a 3rd floor flat with frontage to Seven Sisters Road. The elevated position at the building façade set back from the road gave some helpful separation from the influence of road-traffic noise when compared to taking measurements at the road-side.

Figure 1: Finsbury Park showing monitoring position (3rd floor balcony) on Seven Sisters Road

3.5 As I walked around the area carrying out monitoring and observations I did notice, shortly after 19:00hrs, somebody carrying out measurements of noise levels on Seven Sisters Road. The person was seated on a small chair on the pavement and had a microphone on a tripod at approximately ear height. When I returned to the area approximately 30 minutes later that person had left. Any noise recorded on the pavement of the road at this location would have been significantly influenced by noise from the constant road traffic at this location.

3.6 No other noise measurement activity was noted in the community other than this one incident on Seven Sisters Road. No noise logging equipment was visible at the measurement points stated on the licence.

4.0 Criteria

Licensing Act 2003

4.1 Haringey Council ("The Council") has a duty under the Licensing Act 2003 to determine its policy with respect to the exercise of its licensing functions and to publish a statement of that policy. The current Statement of Licensing Policy ("SLP") is for the period 2016 - 2021.

4.2 The council's aim is to promote the four licensing objectives:

- The prevention of crime and disorder
- Public safety
- The prevent of public nuisance
- The protection of children from harm

4.3 The SLP states, at paragraph 88: *"Haringey Parks host a number of events throughout the year... Licensees are expected to have regard to the Licensing Policy as well as address the following elements:*

a) Overall event safety control
b) Production details
c) Medical and first aid provision
d) Site management and the structural integrity of all temporary structures
e) Crowd management, stewarding and security
f) Fire safety and control
g) Configuration and control of sound systems
h) Management of any on-site and off-site car parking
i) Management of concessions and franchises
j) Provision and maintenance of water supplies
k) Welfare and provision of information
l) Provision and maintenance of sanitary facilities
m) Reception collection and removal of litter and other waste
n) Liaison with local residents and businesses"

4.4 Licensable activities for the event are granted under Premises Licence Number LN/000012182 issued by the Licensing Authority, London Borough of Haringey, on 16th December 2013.

5.0 Noise measurement procedure

5.1 Noise levels were continuously recorded from a 3rd floor balcony at the front façade of the block of residential flats at the location shown in Figure 1. The measurement microphone was mounted at a distance of >1m from any reflective surface.

5.2 Noise measurements were made in continuous samples of 1-second intervals. Measurements included the L_{Aeq}, L_{A90} and L_{Amax} indices. Simultaneous octave and third octave frequency spectra were also obtained during the survey.

5.3 Additional noise measurements were made with a hand-held measurement system at other locations in the immediate area. Measurements were taken at 1.5m above grade level. Measurement duration was 5-minutes per sample.

5.4 Analysis shows good correlation between the attended and unattended recorded noise level data at the logging position. Throughout the course of the survey outdoor microphone windshields were used.

5.5 For the purposes of this assessment all attended measurements were paused for emergency service sirens, aircraft passes and other significant short-duration noises. The unattended logging equipment operates continuously and therefore all noise incidents are recorded on that system.

5.6 The instrumentation used to carry out the noise measurements is detailed in Appendix B. The calibration of the measuring equipment was checked prior to and immediately following the tests and no signal variation occurred. Calibration of equipment is traceable to national standards.

5.7 The weather conditions during the survey are reported in Appendix C.

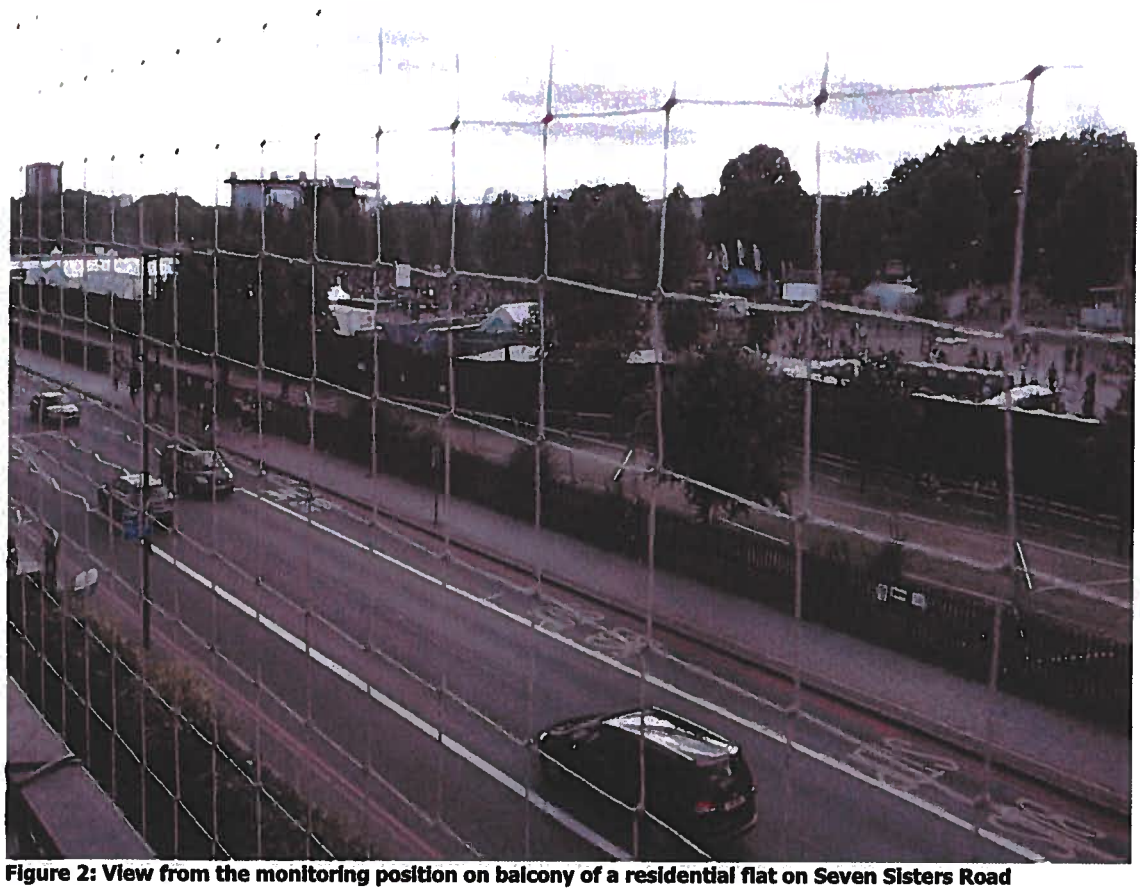


Figure 2: View from the monitoring position on balcony of a residential flat on Seven Sisters Road

6.0 Noise measurement analysis

6.1 Measurement data gathered from the logging position on Seven Sisters Road are presented in graphical form in Figures 3-7.

6.2 Figure 3 shows the A-weighted recorded noise levels. A-weighted levels are middle and high frequency sounds so these data effectively exclude bass. What is evident is that there are two periods of high noise. The first occurs from approximately 19:11-20:05 and the second from 20:46-21:49. This correlates with the set times for the artist Travis Scott first, then followed by Skepta who was the headline act for Saturday night.

6.3 Figure 4 is the graph of very low bass only: the octave centred on 31.5 Hz[1]. These sounds are sometimes referred to as *sub-bass*. Sounds in this octave are most commonly created by electronic instruments as traditional acoustic instruments do not produce very low bass sounds with significant levels of energy. What is clearly evident from these data is that the first set, Travis Scott, had considerably more very low frequency energy than the later Skepta set. A characteristic difference between the two sets is that the first set had continuous bass throughout the set, which would be caused by sustained low frequency notes, the second set shows on the graph as much *spikier* indicating only occasional bass peaks in the programme and with average levels far lower. The average 31.5Hz octave band level during Travis Scott was 89dB with some peaks of 95dB. In contrast Skepta averaged 77dB and the highest peak was 86dB.

[1] For a typical nightclub or music venue sound system often this 'lowest' octave is not reported as smaller scale PA systems, and PA systems operating indoors, are simply unable to create much energy at these *very* low frequencies.

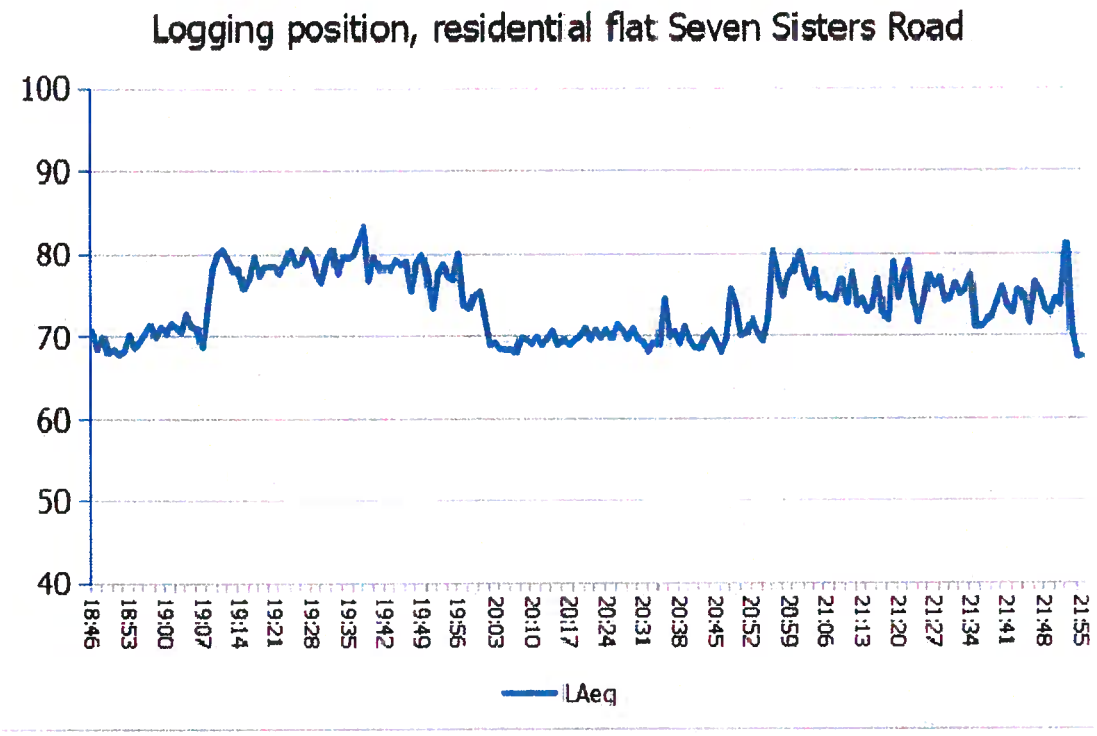


Figure 3: A-weighted sound pressure levels, dB

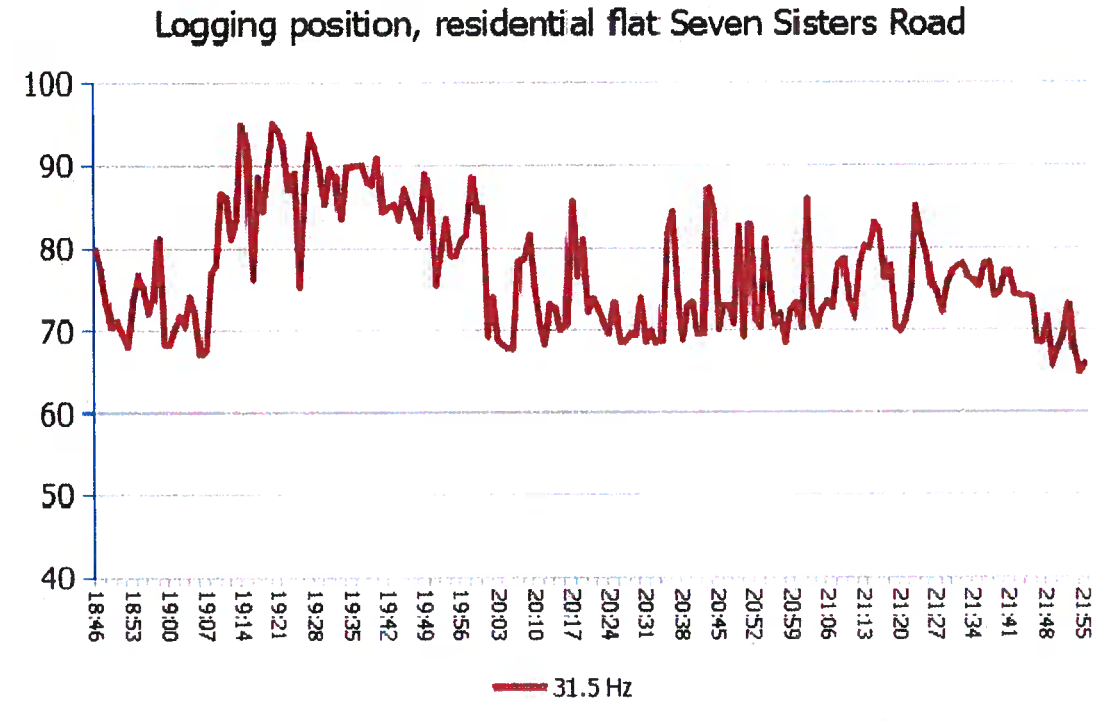


Figure 4: Sound pressure level in dB measured in the octave band centred at 31.5Hz (very low bass)

Figure 5: Sound pressure level in dB measured in the octave band centred at 63Hz (bass)

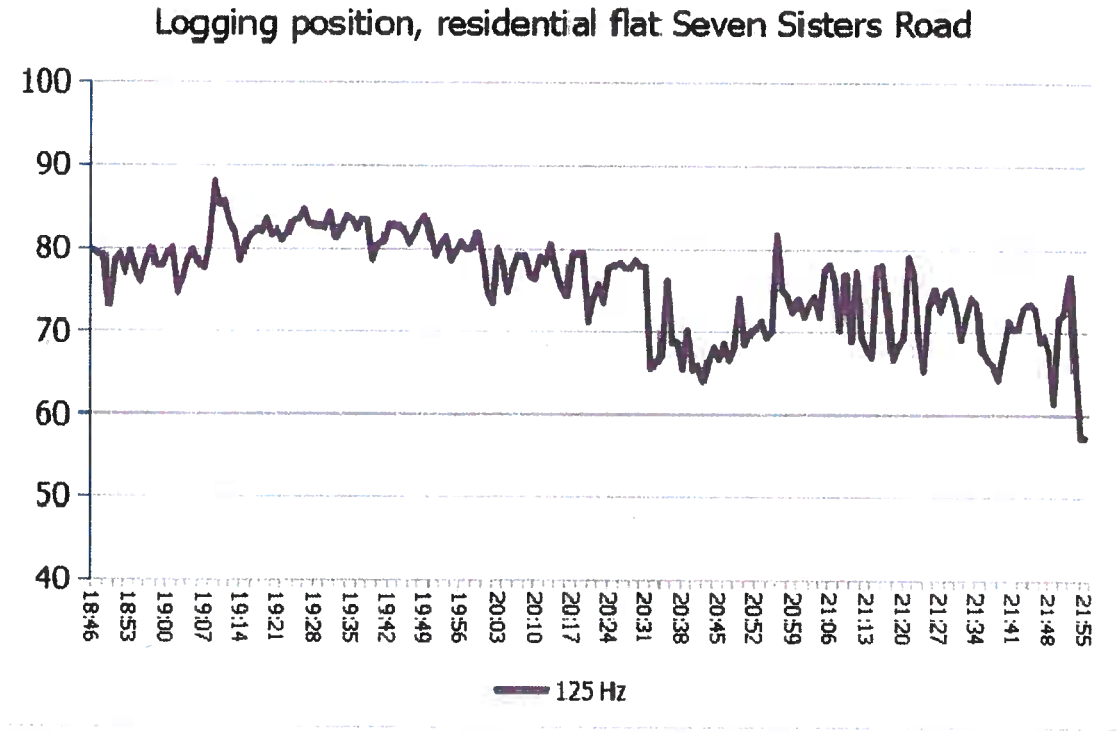


Figure 6: Sound pressure level in dB measured in the octave band centred at 125Hz (upper bass)

6.4 For the very low bass frequencies there are differences of around 10-12dB in the measured levels between the two sets on the same evening performing on the same stage with the same sound system to the same crowd. There is also a difference in A-weighted levels (see Figure 3) but there is a smaller difference between the two sets with the Travis Scott measuring in the upper seventies dBA and Skepta measured in the mid-seventies dBA.

6.5 Figure 5 is what we consider more typically to be normal bass, it is the octave centred on 63Hz, and it is in this range that sounds from kick drums and bass guitars exist. The first set is again the one with the most bass energy and the flatest trace (i.e. more continuous bass) with the second set showing lower average levels and a more spikey trace.

6.6 Figure 6 is the octave band centred on 125Hz and this contains the middle register of a bass guitar and the lowest notes on a guitar. Once again the first set measures higher bass noise levels and more continuously high levels than the second set.

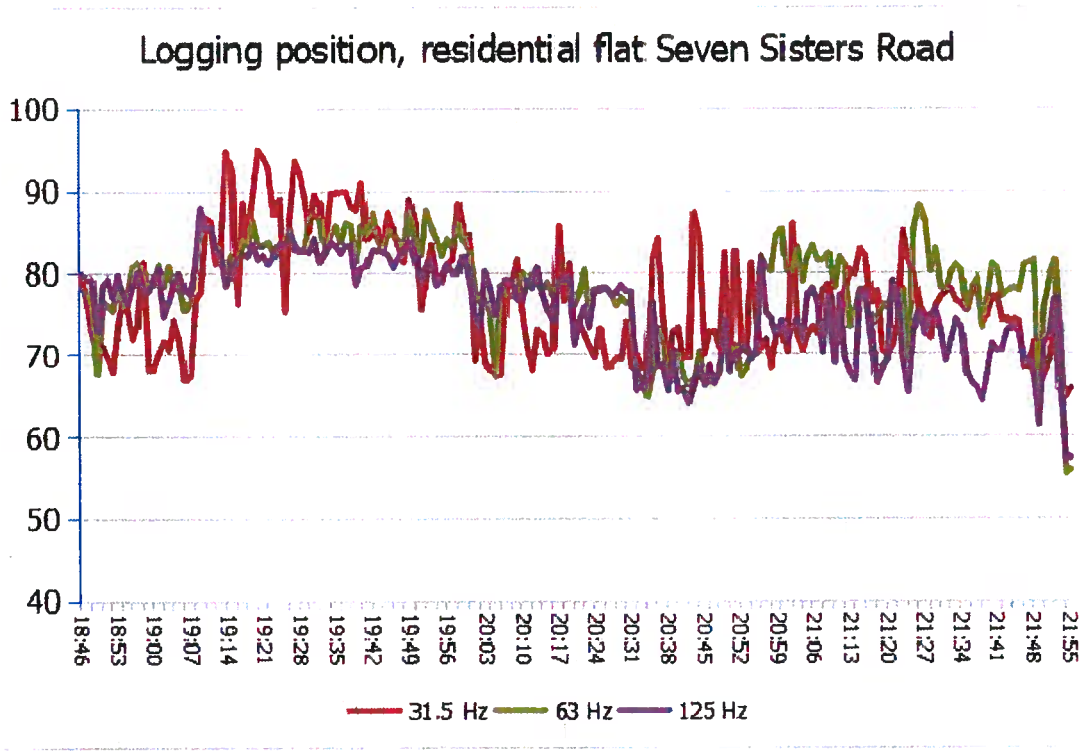


Figure 7: Sound pressure level in dB measured in three octave bands centred at 31.5Hz, 63Hz & 125Hz.

6.7 Figure 7 combines all three bass measurements from the preceding graphs and again the higher bass energy in the first set from approximately 19:11-20:05 is evident when compared to the second set at 20:46-21:49. The impact of bass sound on the local community was significantly greater in the case of the Travis Scott set whereas the headline act, Skepta, had less bass and caused less impact in the surrounding residential areas.

7.0 Noise levels in surrounding roads

7.1 Between 19:15 and 19:40 I was in Wilberforce Road. I carried out assessments from street level and also from a first floor flat. In the street I measured noise levels as high at 97dB in the octave centred on 31.5 Hz with frequent exceedences above 90dB. This amount of low frequency energy results in windows rattling. Sash windows in properties could be clearly heard vibrating in the street sometimes rattling for prolonged periods during sustained bass notes created by synthesised electronic bass in the Travis Scott performance.

Figure 8: View south-east down Wilberforce Road. Sash windows in houses at this location could be heard rattling from the street due to low frequency sound from the Park.

7.2 Inside the flat on Wilberforce Road noise levels were disruptive even with windows closed and were at a level that would prevent normal resting and sleeping. The residents explained that they were leaving to visit friends elsewhere as soon as I had finished my assessment as they did not wish to remain in their flat and be subjected to the noise. They discussed the impact on their home life and ability to relax, and were concerned that small children and babies would be distressed by the rattling of windows and the intrusive bass noise inside their home.

7.3 I then visited Adolphus Road. There is little traffic on this road and music noise was clearly audible and dominated the noise climate. At one point during my measurement a child passed and seeing me holding my sound meter shouted *"It's really loud!"*

7.4 I then moved to Alexandra Grove by which time the Travis Scott set had finished and there was a break during changeover. I waited in Alexandra Grove and visited a flat with a roof terrace. When the final set of the evening started the music noise was noticeable, but had notably less low frequency content than the previous set. It was in my view, and that of the residents with the roof terrace, notably less intrusive than the previous performance.

8.0 The noise source

8.1 The sound system used on the main stage was a large scale professional PA system manufactured by the French loudspeaker company L'Acoustics. The bass array consisted of thirty KS28 loudspeakers. Each loudspeaker has an extended low frequency down to 25Hz, i.e. they are designed to operate in the lowest measured octave centred on 31.5Hz. The loudspeakers are powered by one dedicate channel of amplification per loudspeaker with each amplifier channel rated at 2600W. That is thirty 2600W amplifier channels making a total of 78,000 Watts of amplification just for low frequency sound. This is a very large scale PA system for an urban location and is capable of producing extremely high levels of bass energy.

9.0 Noise conditions in the existing premises licence

9.1 Licensable activities for the event are granted under Premises Licence Number LN/000012182 issued by the Licensing Authority, London Borough of Haringey, on 16th December 2013. The licence only comes into effect *"once hire of the park is agreed with the Parks Service of Haringey Council".* It permits live and recorded music from 10:00 - 22:30 Monday to Saturday and 10:00 - 22:00 on a Sunday.

9.2 The following conditions relate to noise: 98, 99, 101, 102, 103, 104, 105, 106, 107, 108, 109.

9.3 The only constraint on specific noise levels is in Condition 107 which reads:

"Sound levels should not exceed the above background by more than 15dB when measured as a 15 minute L_{Aeq}."

9.4 Where this condition states "the above background" it is assumed to mean the background noise levels quoted in Condition 106 which is a table of noise levels.

9.5 Condition 107 is a significantly flawed noise condition and does not assist in the prevention of public nuisance because:

a) The use of fixed background levels (i.e. those tabled under Condition 106) means that the boundary level of all future events is dependent on the validity of these historic background noise levels at these specific locations. Boundary noise conditions should relate to the background level at the present time, not historic data as the area may change resulting in higher or lower noise levels.

b) Some of the measurement positions (those reporting highest levels) are significantly influenced by road traffic noise. Measurement of A-weighted levels is significantly corrupted by road traffic noise which can mask the contribution from music. However in streets away from heavy road traffic music noise considerably exceeds the minimal traffic noise.

c) The boundary noise level measurement positions are effectively locked to six fixed positions by this condition. Boundary noise conditions should apply at all noise sensitive locations, not just six fixed locations.

d) No reference is made to low frequency (bass) noise in any of the conditions: The noise criteria rely solely on "A-weighted" measurements and therefore fail to quantify, and therefore control, low frequency noise.

9.6 The background noise levels given in Condition 106 range from 41dBA (Stapleton Hall Road) to 63dBA (Seven Sisters Road) and therefore, using the +15dBA

criterion of Condition 107, the maximum boundary music noise levels would fall in the range of 56 - 78 dB $L_{Aeq,15mins}$, i.e. at the very loudest measurement position on Seven Sisters Road the music noise level must not exceed $L_{Aeq,15mins}$ = 78dBA.

9.7 The 78dBA noise limit on Seven Sisters Road is misleading and ineffective. It relies on one very noisy measurement position next to a busy road ignoring the large expanse of residential properties beyond that road that are shielded from road traffic noise, but not from amplified music propagating from the festival sound systems.

9.8 78dBA as a noise limit in front of a residential property is, to the best of my knowledge, higher than any other event noise condition in London.

9.9 The actual assessment and demonstration of compliance with this noise level at a location next to a busy road is difficult as the noise measurement will be influenced by traffic noise and therefore any recording that exceeds 78dBA could be excused as corrupted due to other noise sources.

9.10 Typically it will be the quieter façades of residential properties (those façades further from busy roads) that would require the greatest protection as residents on main roads may already choose to rest and sleep on the quieter side of their property or install alternative means of ventilation so that windows do not need to be opened. Therefore the impact of the festival noise on the quieter roads away from traffic noise should be given more weight and assessment should be carried out from these locations.

9.11 The simple conditions on noise limits for such large scale events do not align with the guidance in the 'Code of Practice on Environmental Noise Control at Concerts' document produced by The Noise Council. Even though this is an old and not a particularly sophisticated guidance document it does clearly state:

- At paragraph 3.1: *The music noise levels should not exceed the guidelines at 1 metre from the façade of ANY noise sensitive property.*
- At paragraph 3.4: *Assessment of noise in terms of dB(A) is very convenient but it can underestimate the intrusiveness of low frequency noise. Furthermore, low frequency noise can be very noticeable indoors. Thus, even if the dB(A) guideline is met, unreasonable disturbance may be occurring because of the low frequency noise. With certain types of events, therefore, it may be necessary to set an additional criterion in terms of low frequency noise, or apply additional control conditions.*

10.0 A-weighted measurement informative

10.1 A-weighted measurements are effectively the middle and upper frequencies only of the audio spectrum as the A-weighted curve gradually excludes lower and lower frequencies diminishing the effect of bass sounds on the overall measurement. This is a significant shortcoming when assessing noise from amplified music.

10.2 The A-weighted curve applied in the calculation of L_{Aeq} values increasingly weights (excludes) the frequencies below 1kHz, see Figures 9 and 10. The curve attenuates the levels in each octave band and at the commonly understood bass frequencies the level is so significantly attenuated that bass sounds have minimal impact on the resultant single-figure measurement value.

10.3 Figure 9 shows that measurements in the 63Hz octave band are adjusted when A-weighted by -26dB, and in the 31.5Hz band by -39dB making them have only a very small influence on the overall A-weighted measurement figure.

Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000
A-weighting dB(A)	**-39.4**	**-26.2**	**-16.1**	-8.6	-3.2	0	1.2	1	-1.1
C-weighting dB(C)	-3	-0.8	-0.2	0	0	0	-0.2	-0.8	-3
Z-weighting dB(Z)	0	0	0	0	0	0	0	0	0

Figure 9: The significant attenuation of bass octaves from A-weighted curve is shown in bold

10.4 A Z-weighted measurement would not attenuate bass at all as it is *zero* weighted. The C-weighted measurement, also shown graphically in green in Figure 10, has only a small level of low frequency attenuation. In contrast the A-weighted curve shown in red rapidly rolls off excluding low frequency measurement.

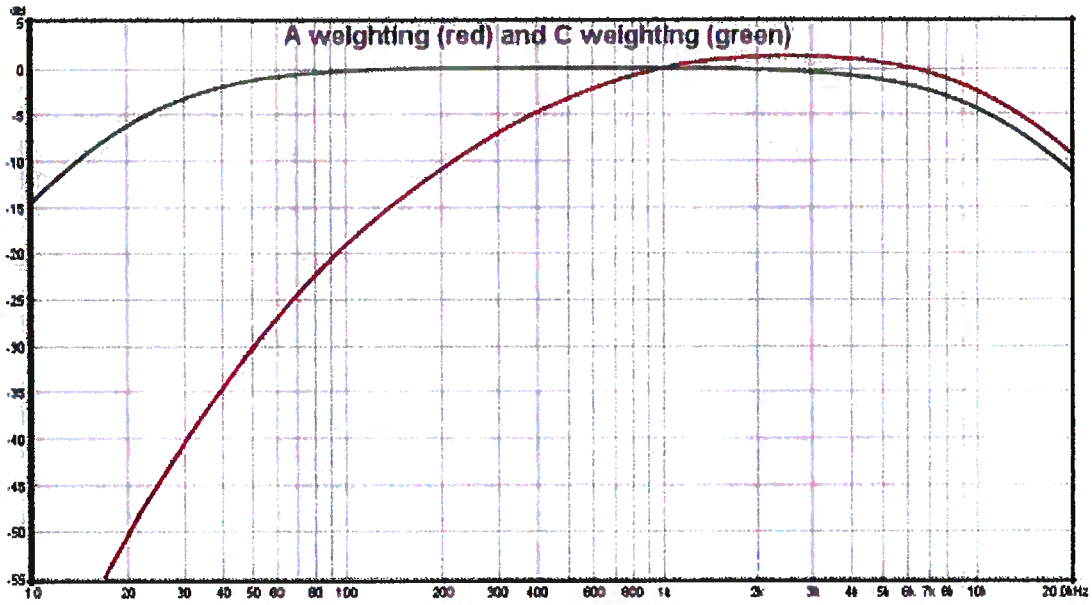


Figure 10: The A-weighted curve shown in red excludes low frequency sound

10.5 Modern sound meters have filter sets that allow even more specific analysis of separate octave bands allowing for greater control of the specific bass bands of music. Good practice would be to evaluate the 125Hz octave band, the 63Hz octave band, and in the case of some music genres an assessment of the 31.5Hz octave band is also appropriate.

10.6 In summary bass, the major source of irritation and most common cause of nuisance complaint regarding music noise, is effectively omitted from A-weighted measurements.

11.0 Trends in sound system technology and music style require noise conditions that are fit for purpose

11.1 Development in loudspeaker technology, amplifier design and sound system control has led to sound systems that are capable of producing significantly greater levels of bass than ever before. This technological development combined with musical genres that favour synthesised electronic sounds has resulted in the ability to reproduce levels of low frequency energy in the surrounding community that were at one time simply not possible.

11.2 Going back to the early era of music festivals the PA system used at The Stones In The Park (Hyde Park, 1969) was a mere 1500 Watts and highly unreliable too. Equipment availability and reliability were the limiting factor preventing very loud events for at least the next decade. As PA efficiency and reliability improved through the nineteen-eighties and nineties higher sound levels were achievable up to the point where one limiting factor became excessive stage noise levels: the performers themselves were so close the the large PA stacks they were subjected to excessive noise levels from the main PA and engineers struggled to use microphones on stage for acoustic instruments without feedback. Although much louder than the early days of amplified music the maximum level was, to some extent, still self-regulating. Today advanced techniques in near-field sound control using loudspeaker array steering and noise cancellation methods to create a quieter zone on stage and back stage allows even greater levels in the main arena without causing disruption on stage. Music noise sources that are not acoustic such as synthesisers, drum machines and backing tracks, are not limited by the effects of microphone feedback as they are directly injected into the sound system.

11.3 The accepted guidance document for noise from infrequent outdoor music events is the 'Code of Practice on Environmental Noise Control at Concerts', produced by The Noise Council in 1995. It acknowledges the intrusiveness of low frequency noise but does not go into a great deal of detail beyond that. It is still regularly referenced but it must be acknowledged that it is over 22 years old.

11.4 Occasionally a 2006 research document from DEFRA[2] into amplified music noise is also referenced as it is a later piece of work on disturbance from music noise. This was a notable report in that it concluded that an absolute A-weighted level was a reliable method to assess intrusive music noise. Any exceedence above this permitted level[3] would trigger enforcement action under the Noise Act 2006.

11.5 The limitations of the DEFRA research into absolute levels are partly acknowledged in the report itself: The study only relates to entertainment noise from inside and within the curtilage of pub and club type licensed premises. It concludes that the absolute L_{Aeq} was only relevant beyond 23:00hrs. The DEFRA research was also somewhat constrained by the laboratory conditions used at the Building Research Establishment and the small-scale semi-professional sound equipment used including loudspeakers of a type and scale that may be suited to the back room of a pub but would never be used at a festival and would not produce the level, or extended low frequencies, of the system used for Wireless Festival 2017. The DEFRA document can only be considered relevant to low level music noise from a pub late at night and is of no relevance to the much higher level, and lower frequency, noise from a festival site.

[2] NANR163: Noise from Pubs and Clubs (Phase II) May 2006

[3] The permitted level is set at 34 dBA if the underlying level of noise is no more than 24 dBA, or 10dBA above the underlying level of noise where this exceeds 24 dBA

12.0 Suggested controls for future events

12.1 It is clear that a simple approach to boundary noise level controls has historically been taken at the site. These noise conditions are not effective in upholding the licensing objective of the prevention of public nuisance.

12.2 The premises licence noise conditions require re-working and consideration must be given to the following recommendations:

- Boundary noise conditions should apply at *all* noise sensitive properties not just a select few.
- The limit level should be based on up to date survey of background noise levels taken at locations away from other noise sources because these existing noise sources have resulted in artificially high boundary levels being set that are irrelevant for most of the properties away from busy roads.
- There must be limit levels on low frequency noise.

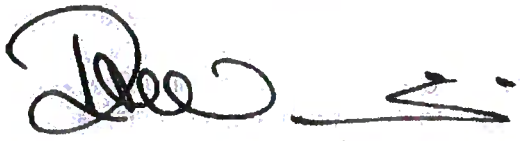
13.0 Conclusions

13.1 Big Sky Acoustics Ltd was instructed by Mr Tom Palin of The Friends Of Finsbury Park (FOFP) to carry out an assessment of the impact of noise from Wireless Festival 2017 on nearby residential properties.

13.2 A site visit, inspection of the Park, and monitoring of noise levels during Wireless Festival 2017 was carried out. Measurements of noise levels at residential properties during Saturday evening demonstrate that one performer with very high levels of bass energy was correspondingly very intrusive in the residential community, whereas a later (headline) act with more controlled bass had a lesser effect. This variability exists from genre to genre as well as from engineer to engineer and is not controlled by the existing noise conditions.

13.3 Advances in professional audio equipment has resulted in the potential for festival noise to far exceed the levels possible during the research and preparation of published industry guidance which is out of date. More recent research into intrusive noise from music has been limited and is not directly relevant to sound systems of the scale and capability that are now used for festivals.

13.4 A review of the existing premises licence condition must consider the re-evaluation of the existing A-weighted boundary noise level limits, the addition of low-frequency controls, and the application of these limits to all residential properties. There is no indication that this would curtail the commercial viability of music events in Finsbury Park but it would ensure that an element of control exists to protect residents from public nuisance caused by some engineers and performers that seek to create the very highest levels of bass available from modern large-scale sound systems.



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Appendix A - Terminology

Sound Pressure Level and the decibel (dB)
A sound wave is a small fluctuation of atmospheric pressure. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. In order to cope with this wide range of pressure variations, a logarithmic scale is used to convert the values into manageable numbers. Although it might seem unusual to use a logarithmic scale to measure a physical phenomenon, it has been found that human hearing also responds to sound in an approximately logarithmic fashion. The dB (decibel) is the logarithmic unit used to describe sound (or noise) levels. The usual range of sound pressure levels is from 0 dB (threshold of hearing) to 140 dB (threshold of pain).

Frequency and Hertz (Hz)
As well as the loudness of a sound, the frequency content of a sound is also very important. Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or hertz (Hz). Sometimes large frequency values are written as kilohertz (kHz), where 1 kHz = 1000 Hz. Young people with normal hearing can hear frequencies in the range 20 Hz to 20,000 Hz, however the upper frequency limit gradually reduces as a person gets older.

A-weighting
The ear does not respond equally to sound at all frequencies. It is less sensitive to sound at low and very high frequencies, compared with the frequencies in between. Therefore, when measuring a sound made up of different frequencies, it is often useful to 'weight' each frequency appropriately, so that the measurement correlates better with what a person would actually hear. This is usually achieved by using an electronic filter called the 'A' weighting, which is built into sound level meters. Noise levels measured using the 'A' weighting are denoted dBA. A change of 3dBA is the minimum perceptible under normal everyday conditions, and a change of 10dBA corresponds roughly to doubling or halving the loudness of sound.

C-weighting
The C-weighting curve has a broader spectrum than the A-weighting curve and includes low frequencies (bass) so it i can be a more useful indicator of changes to bass levels in amplified music systems.

Noise Indices
When a noise level is constant and does not fluctuate over time, it can be described adequately by measuring the dB level. However, when the noise level varies with time, the measured dB level will vary as well. In this case it is therefore not possible to represent the noise level with a simple dB value. In order to describe noise where the level is continuously varying, a number of other indices are used. The indices used in this report are described below.

- L_{eq} The equivalent continuous sound pressure level which is normally used to measure intermittent noise. It is defined as the equivalent steady noise level that would contain the same acoustic energy as the varying noise. Because the averaging process used is logarithmic the L_{eq} is dominated by the higher noise levels measured.
- L_{Aeq} The A-weighted equivalent continuous sound pressure level. This is used as the preferred parameter for environmental noise.
- L_{Ceq} The C-weighted equivalent continuous sound pressure level includes low frequencies and can be used for assessment of sound that has low frequency content such as music.
- $L_{eq,63Hz}$ The equivalent continuous sound pressure level measured in a one octave wide frequency band centred on 63Hz. This is used for bass measurements of music systems and was traditionally the lowest octave measured, however modern loudspeaker systems are capable of producing significant amounts of energy at frequencies that are below this band.
- $L_{eq,125Hz}$ The equivalent continuous sound pressure level measured in a one octave wide frequency band centred on 125Hz (the octave band above the 63Hz octave band) also covering what are subjectively considered bass sounds.
- L_{Amax} is the maximum A-weighted sound pressure level during the monitoring period. If fast-weighted it is averaged over 125 ms , and if slow-weighted it is averaged over 1 second. Fast weighted measurements are therefore higher for typical time-varying sources than slow-weighted measurements.
- L_{A90} is the A-weighted sound pressure level exceeded for 90% of the time period. The L_{A90} is used as a measure of background noise.

Example noise levels:

Source/Activity	Indicative noise level dBA
Threshold of pain	140
Police siren at 1m	130
Chainsaw at 1m	110
Live music	96-106
Symphony orchestra, 3m	102
Nightclub	94-104
Lawnmower	90
Heavy traffic	82
Vacuum cleaner	75
Ordinary conversation	60
Car at 40 mph at 100m	55
Rural ambient	35
Quiet bedroom	30
Watch ticking	20

Appendix B - Instrumentation

Measurements were carried out using a Cirrus type CR:171B integrating-averaging sound level meter with real-time 1:1 & 1:3 Octave band filters and audio recording conforming to the following standards: IEC 61672-1:2002 Class 1, IEC 60651:2001 Type 1 I, IEC 60804:2000 Type 1, IEC 61252:1993 Personal Sound Exposure Meters, ANSI S1.4-1983 (R2006), ANSI S1.43-1997 (R2007), ANSI S1.25:1991. 1:1 & 1:3 Octave Band Filters to IEC 61260 & ANSI S1.11-2004.

The calibration of the measuring equipment was checked prior to and immediately following the tests and no signal variation occurred. Calibration of equipment is traceable to national standards. The following instrumentation was used during the survey:

Description	
Cirrus sound level meter	type CR:171B
Cirrus pre-polarized free-field microphone	type MK:224
Cirrus microphone pre-amplifier	type MV:200E
Cirrus class 1 acoustic calibrator	type CR:515

Appendix C - Meteorology

8th July 2017	Temperature	Wind speed	Precipitation
At start	24°C	0-1ms^{-1}	None
During assessment	18°C	0-3ms^{-1}	None
At finish	17°C	0-1ms^{-1}	None
Additional comments: Dry summer day. Good measurement conditions.			

Appendix D - Bass loudspeakers used on main stage

(30 of these were used in the main stage system at Wireless Festival 2017)

KS28 REFERENCE SUBWOOFER

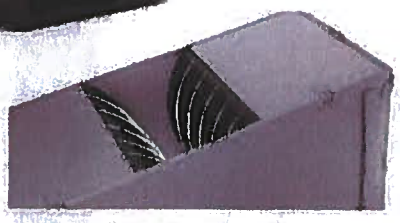
- **+ 3 dB SPL (vs. SB28)**
- **79 kg /174 lbs**
- **Fast and captive rigging**
- **Exclusively driven by LA12X**

ELECTRO-ACOUSTICS

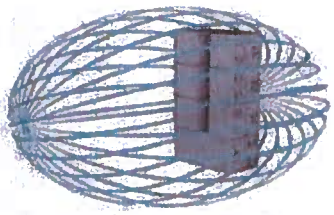
The KS28 is a reference subwoofer designed to extend the frequency response of large format systems. The KS28 features two high excursion, 18" direct radiating transducers mounted in a bass-reflex tuned enclosure. The L-Vents reduce turbulence and port noise at high levels while also increasing LF efficiency.

The KS28 operates from 25 Hz. The excursion capability of the transducer, combined with L-Vents contributes to deliver a high SPL, with low distortion. The KS28 can offer standard or cardioid directivity, by combining physical deployment and the suitable preset.

The KS28 is the first L-Acoustics enclosure to fully utilize the LA12X amplified controller power. The LA12X ensures advanced crossover functions, linearization and LDrive protection of the transducers. Its onboard library offers standard and cardioid presets, each available with two low-pass filters to accommodate various coupling conditions and LF contour requirements.



L-Vents laminar vented ports



Rear SPL rejection (cardioid)

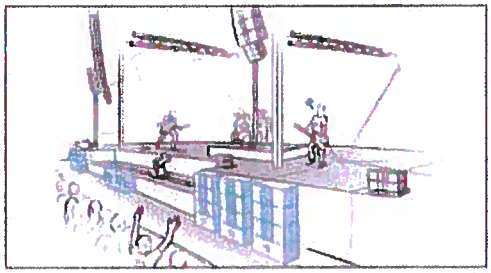
PHYSICAL

The KS28 cabinet is assembled with birch and beech plywood panels. The use of panels optimized for thickness and combined with stiffeners gives the KS28 maximized internal volume, mechanical integrity and a low weight of 79 kg. It feature six ergonomic handles for a solid grip and efficient handling. Bottom and side runners ensure safe stacking. A two-point suspension system is flush-mounted into the cabinet.

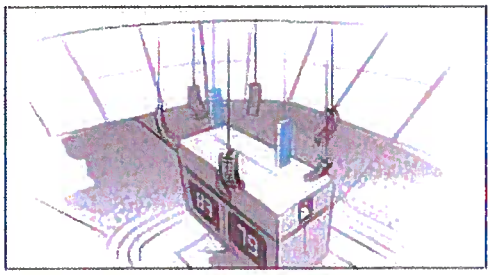
Ergonomic handles; ground and side runners; flush-mounted rigging

APPLICATIONS AND BENEFITS

The KS28 is the ideal companion to large format systems in stacked or flown deployments. KS28 can significantly boost the LF extension and contour of line sources.



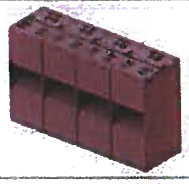
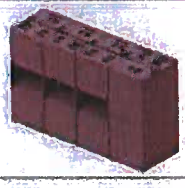
Festival subwoofer system



Installed arena cardioid system

RIGGING

The KS28 can be stacked horizontally or vertically in standard or cardioid arrangements.

	Standard	Cardioid
Vertical[1]		
Horizontal		

1. Possible on KS28-CHARIOT up to 4 units

With KS28-BUMP, KS28 can be flown in vertical arrays of standard or cardioid arrangements, up to 16 units.

	Standard	Cardioid
KS28-BUMP 		

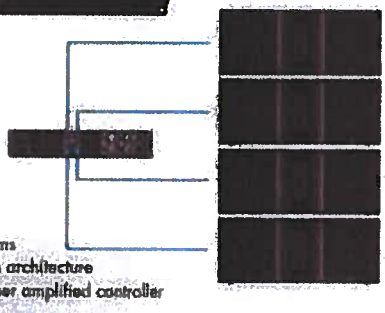
TRANSPORTATION ACCESSORIES

KS28-PLA: removable front dolly on wheels (one KS28)
KS28-COV: protective cover (one KS28)

KS28-CHARIOT: chariot for up to four KS28
KS28-CHARIOTCOV: protective cover for three or four KS28 on KS28-CHARIOT

AMPLIFIED CONTROLLER

LA12X: amplified controller with DSP



4 x 2600 W/4 ohms
4 inputs x 4 outputs architecture
Max 4 enclosures per amplified controller

LA-RAK II: touring rack containing three LA12X, with power, audio and network distribution

ASSOCIATED ENCLOSURES

K1/K1-SB

K2/K1-SB

ARCS II

SOFTWARE

SOUNDVISION: simulation software

3D electro-acoustic & mechanical simulation software

LA Network Manager: control & monitoring software

Real-time control and monitoring up to 253 units
Multiple network topologies

Subwoofers: a complete range for professional sound reinforcement

L-Acoustics subwoofers complement systems in applications where extended bandwidth is required.

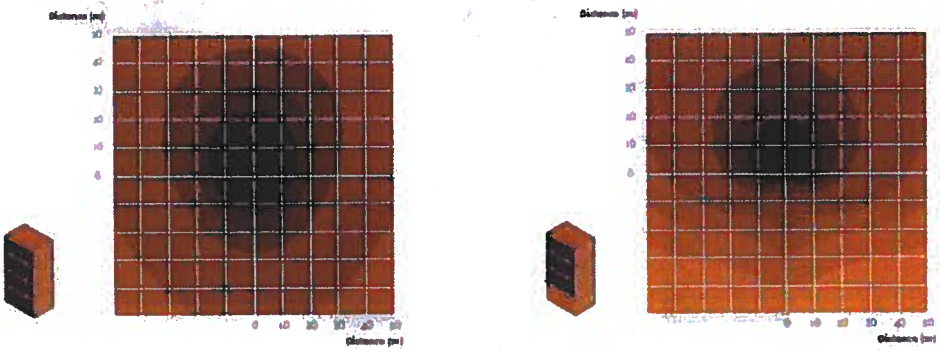
All subs incorporate high excursion drivers, ultra-low vibration walls and laminar airflow L-Vents with a flared profile, resulting in dramatic reduction of port noise, maximized dynamics, power handling and an exceptional level of performance.

SPECIFICATIONS

Description	Flyable subwoofer 2 x 18", amplified by LA12X
Low frequency limit (-10 dB)	25 Hz ([K528_100])
Maximum SPL[2]	143 dB ([K528_100])
Directivity	Standard or cardioid
Transducers	2 x 18" neodymium, aluminium die cast basket
Acoustical load	Bass-reflex enclosure, L-Vent
Nominal impedance	4 Ω
Connectors	IN: 4-point speakON®
Rigging and handling	Flush-fitting 2-point rigging system
	6 ergonomic handles
	2 ground runners
	8 side runners
Weight (net)	79 kg / 174 lbs
Cabinet	Premium grade beech and birch plywood
Front	Steel grill with anti-corrosion coating
	Acoustically neutral 3D fabric
Rigging components	High grade steel
Finish	Dark grey brown PANTONE® 426C

2- Peak level at 1 m under half space conditions using pink noise with crest factor 4 (preset specified in brackets)

ISOCONTOUR



▶ SPL mapping of a block of four K528 in standard (left) and cardioid (right) arrangements, using surfaces of equal sound pressure with three dB step colored scale.

DIMENSIONS