



Soundproof Marquees - Mitigation Strategy

Project. The Tournerbury Woods Estate DRAFT

Proposal No. 388/001

Proposal For: The Tournerbury Woods Estate

Tournerbury Lane

Hayling Island

PO11 9DL

Email: info@tournerbury.com
Tel: 02392 461978

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Prepared by:

Direct Acoustic Solutions Limited
Unit 4 Crawfold Business Park
Balls Cross
West Sussex
GU28 9JT

Proposal for Tournerbury Woods Estate - Soundproof Marquee Mitigation

Direct Acoustic Solutions

Direct Acoustics specialise in controlling amplified music in noise sensitive locations. Our team are experienced in the bespoke design, manufacture and installation of anti-vibration products and isolation mass barriers for architectural noise control in both airborne and structure-borne scenarios. Using our technical knowledge we assist entertainment venues in obtaining licences and gaining planning consent in noise sensitive locations.

Direct Acoustics manufacture, install, service and manage equipment & mitigation strategies to obtain maximum volume levels whilst abiding by specific Institute of Acoustics (IOA) guidelines and environmental health law.

Using the experience we have gained working exclusively with noise sensitive venues, we are able to make a unique offering to The Tournerbury Woods Estate by developing and designing a bespoke soundproof mitigation strategy for their specific environmental conditions.

Brief

Direct Acoustics were invited to propose a suitable acoustic envelope design to attenuate noise emitting from an events marquee venue located at The Tournerbury Woods Estate, Hayling Island.

The design and construction method must have the capacity to control and attenuate the breakout of noise from Tournerbury Woods Estate until 00:00 hours when music and events finish.

The predominant sound source will be amplified music, both live and recorded.



Figure 1

Historic Information

The Tournerbury Woods Estate are currently applying for retrospective planning on the existing wedding venue (APP/18/00943). Within the application comments have been made by neighbours referring to amplified music being audible.

Weddings and events have been held at Tournerbury Woods Estate since 1998. At the point of validation of APP/18/00943, 6th Nov 2018, there has historically been 1 sound complaint lodged with Havant Borough Council EHO (believed to have been in October 2018).

Historically there is evidence that noise complaints have been logged falsely, accusing the estate of disturbance when there has not been an event in operation. Most recently, on the weekend of 25th/26th May 2019, noise complaints were received however the sound source was from the The South Central Festival on King George V playing fields.

The Tournerbury Woods Estate have historically taken the control of amplified music seriously through the means of mitigation systems and management control procedures. An overview of the measures undertaken can be seen below.

On 17th October 2013, The Tournerbury Woods Estate commissioned Mr Owen Clingham BSc (Hons) MIOA FRSA of Auracle Acoustics to undertake a noise assessment establishing the impact that amplified music from the existing venue has on the nearest noise sensitive receptor (NSR).

Auracle Acoustics gathered underlying ambient data measuring $24.1 \text{ dB } L_{Aeq \text{ t15min}}$ and $21.2 \text{ dB } L_{A90 \text{ t15min}}$. Propagation over distance calculations with a conventional point source PA in operation are considered to be excessive and therefore the use of a directional array was suggested when limited to $95 \text{ dB } L_{Aeq}$.

A directional array was installed into The Tournerbury Woods Estate marquee in April 2014 and has been regularly serviced and calibrated by Direct Acoustics each year to ensure that music noise levels do not exceed the $95 \text{ dB } L_{Aeq}$ dance floor level recommended by Auracle Acoustics.

Whilst the Zone Array proves very effective when visiting acts solely operate through it, there is potential for disturbance when live music is in operation due to the additional omnidirectional equipment bands require to perform.

During January 2019, The Tournerbury Woods Estate requested a mitigation strategy to adequately address and attenuate the loudest sound sources brought to the venue by visiting acts.

These are as follows:

- Drum kit – non amplified;
- Guitar amplifiers – amplifies signal from guitars;
- Stage wedge monitors - speakers pointing at the musicians.

All of the above emit sound like a conventional point source system, and the volume these operate at are at the sole control of band members. Due to these speakers emitting sound omnidirectionally, each individual piece of equipment could cause disturbance if played at an excessive level.

To contain the on stage noise generated by visiting live music acts, reduce the impact of patron noise and contain the minimal residual sound emitted from the directional array, Direct Acoustics have employed traditional soundproofing techniques in the form of a 12m x 6m mass acoustic enclosure. Further details on the attenuation composites that were utilised can be seen below.

Mitigation - Soundproof Enclosure

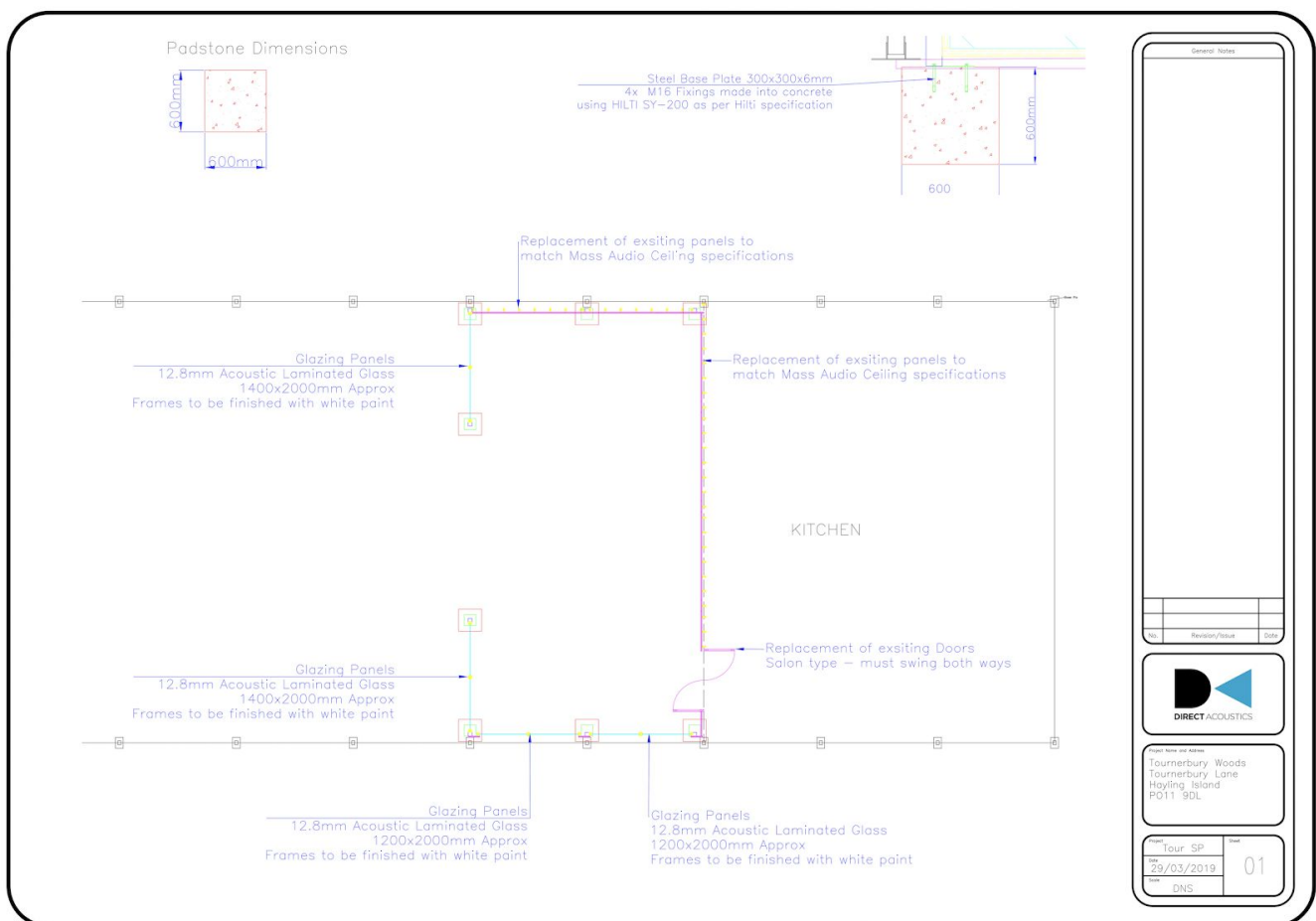


Figure 2

One gable wall was constructed between the catering area and main marquee, with Rw30 doors installed to allow for ingress and egress of staff.

The other gable wall was erected 6m away from the existing with an open frontage to encourage guests into the dance floor area, as detailed in figure 3.

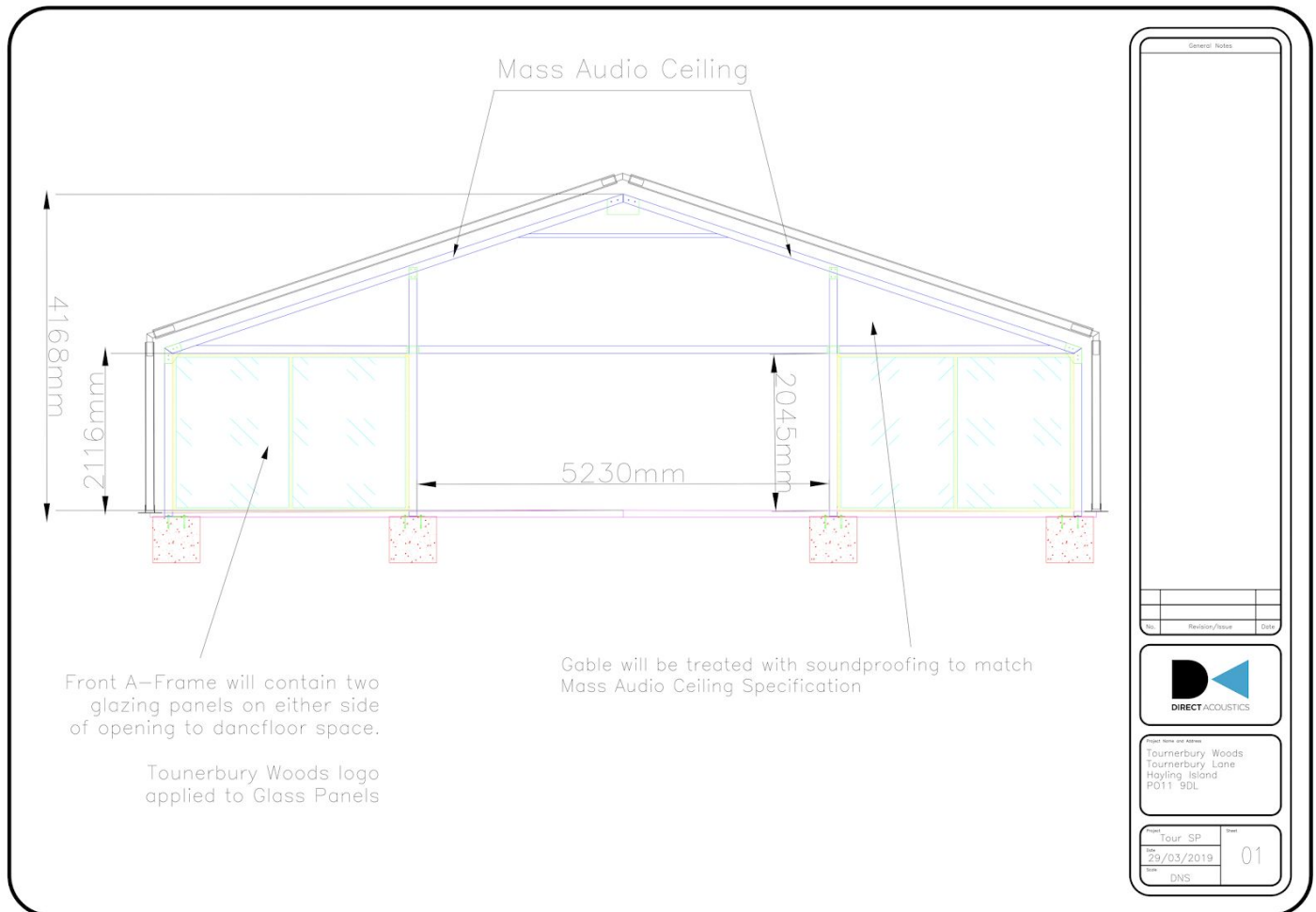


Figure 3

Mass Audio Ceiling/Wall constructions, that are detailed in figures 2 and 3, differ depending on location and access beyond the existing marquee.

Attenuation Composites:

Rear Gable Wall (small aperture)

- 1x 15mm Soundcheck;
- 1 x 3mm acoustic vinyl;
- 1x 15mm Soundcheck;
- 100mm stud - cavity infill - $Rw3$ 60kg/m³ Rockwool;
- 1x 15mm Soundcheck;
- 1 x 3mm acoustic vinyl;
- 1x 15mm Soundcheck;
- 25mm profiled foam.

Using sound reduction computer modelling software, the overall attenuation of the installed

composite to the rear gable wall provides an R_w of 48dB. Frequency specific reductions can be seen in figure 4.

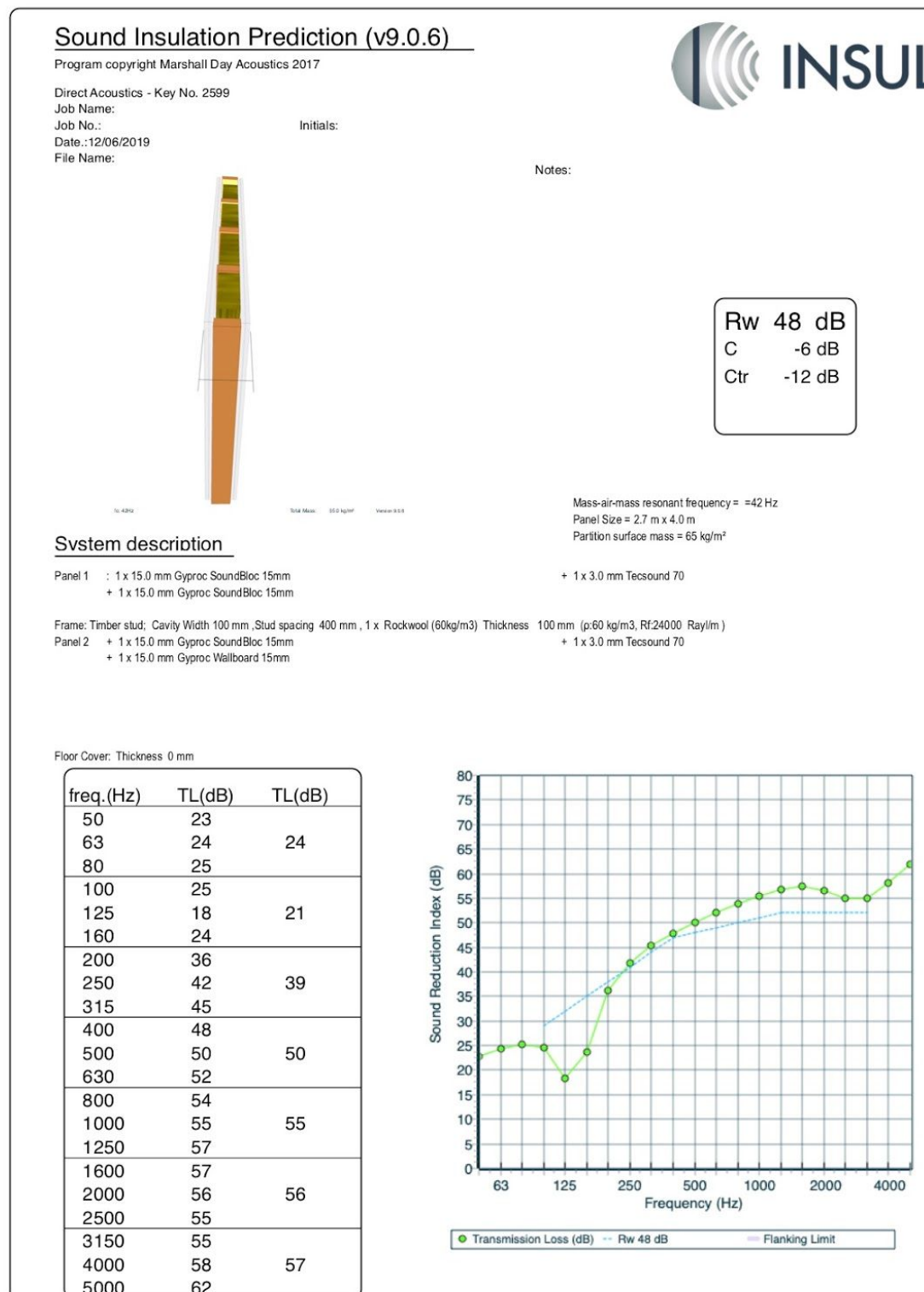


Figure 4

Southern Wall and Gable Triangle

- 1x 12mm plywood;
- 1 x 3mm acoustic vinyl;
- 100mm stud - cavity infill - Rw3 60kg/m³ Rockwool;
- 1x 15mm Soundcheck;
- 1 x 3mm acoustic vinyl;
- 1x 15mm Soundcheck;
- 1 x 3mm acoustic vinyl;
- 1x 15mm Soundcheck;
- 25mm profiled foam.

Please note that, at the request of The Tournurbury Woods Estate, the rear wall has had an additional layer of heavyweight acoustic vinyl and Soundcheck added as this wall takes the most substantial force from acoustic energy from acoustic drum kits and backline amplification with live bands.

INSUL Spec Sheet

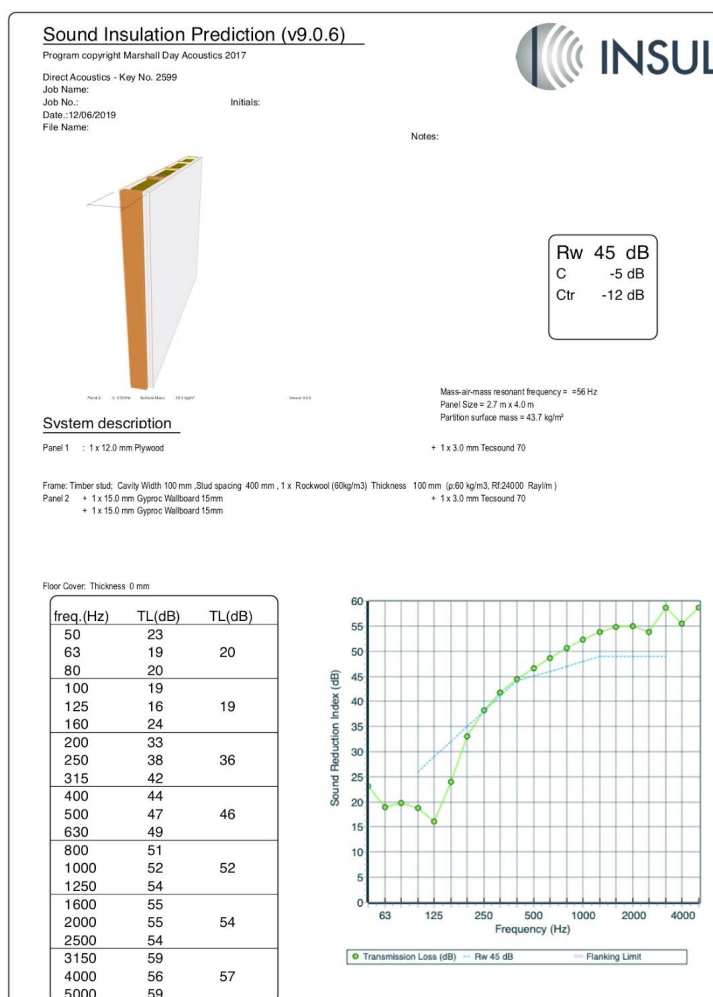


Figure 5

Roof

- 1x 3mm 650g/m² PVC;
- 200mm cavity (no connections);
- 1 x 12mm plywood;
- 1x 15mm Soundcheck;
- 1 x 3mm acoustic vinyl;
- 1x 15mm Soundcheck;
- 25mm profiled foam.

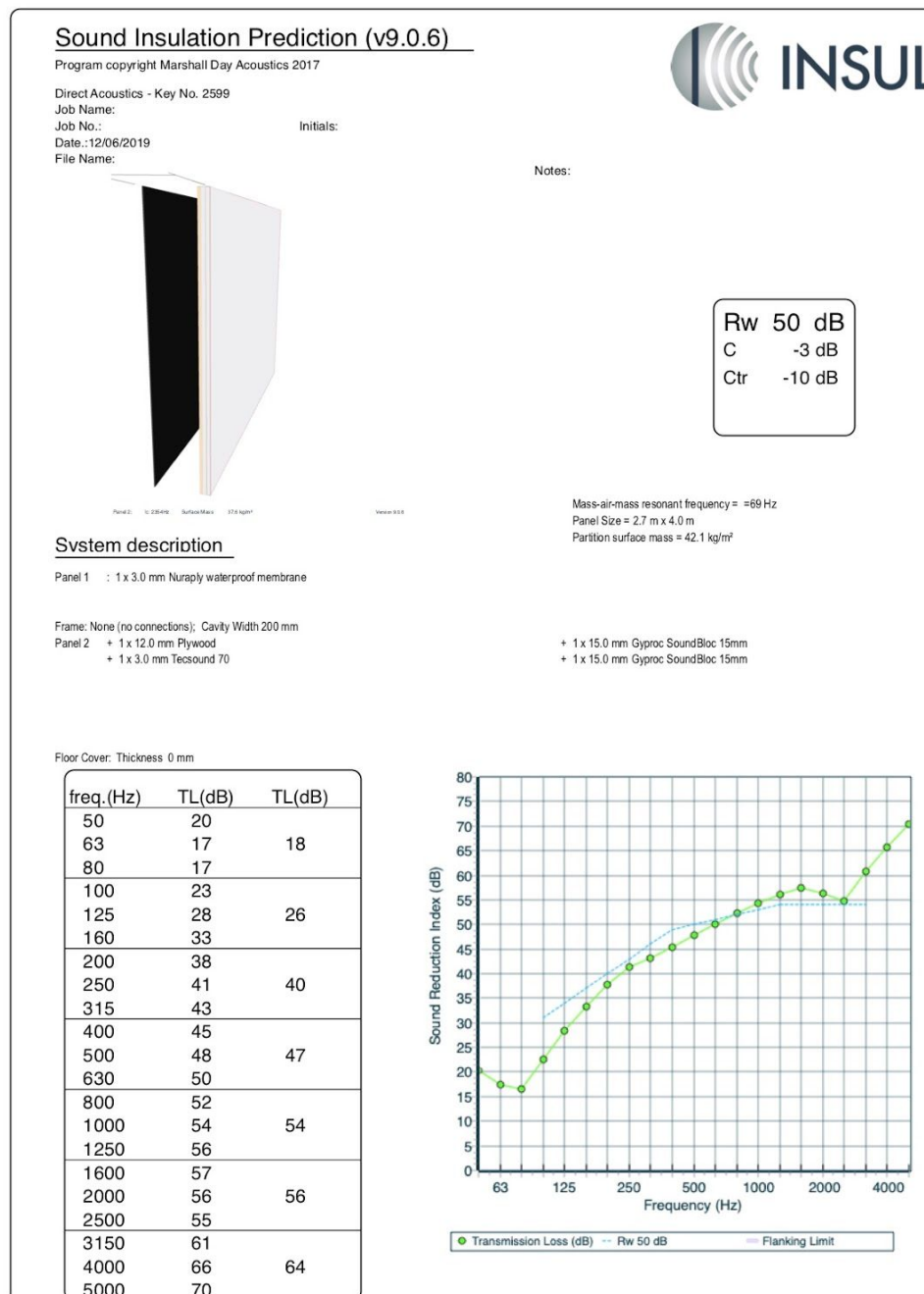


Figure 6

Acoustic Glass

As denoted in figures 2 and 3 there are six acoustic glass panes to allow light in the demountable structure, however to ensure that no acoustic weak leak is formed, a 12.8mm acoustic glass variant has been installed, offering a 37dB reduction.

- 6.8mm toughened glass;
- 0.8mm acoustic resin;
- 6.8mm toughened glass;

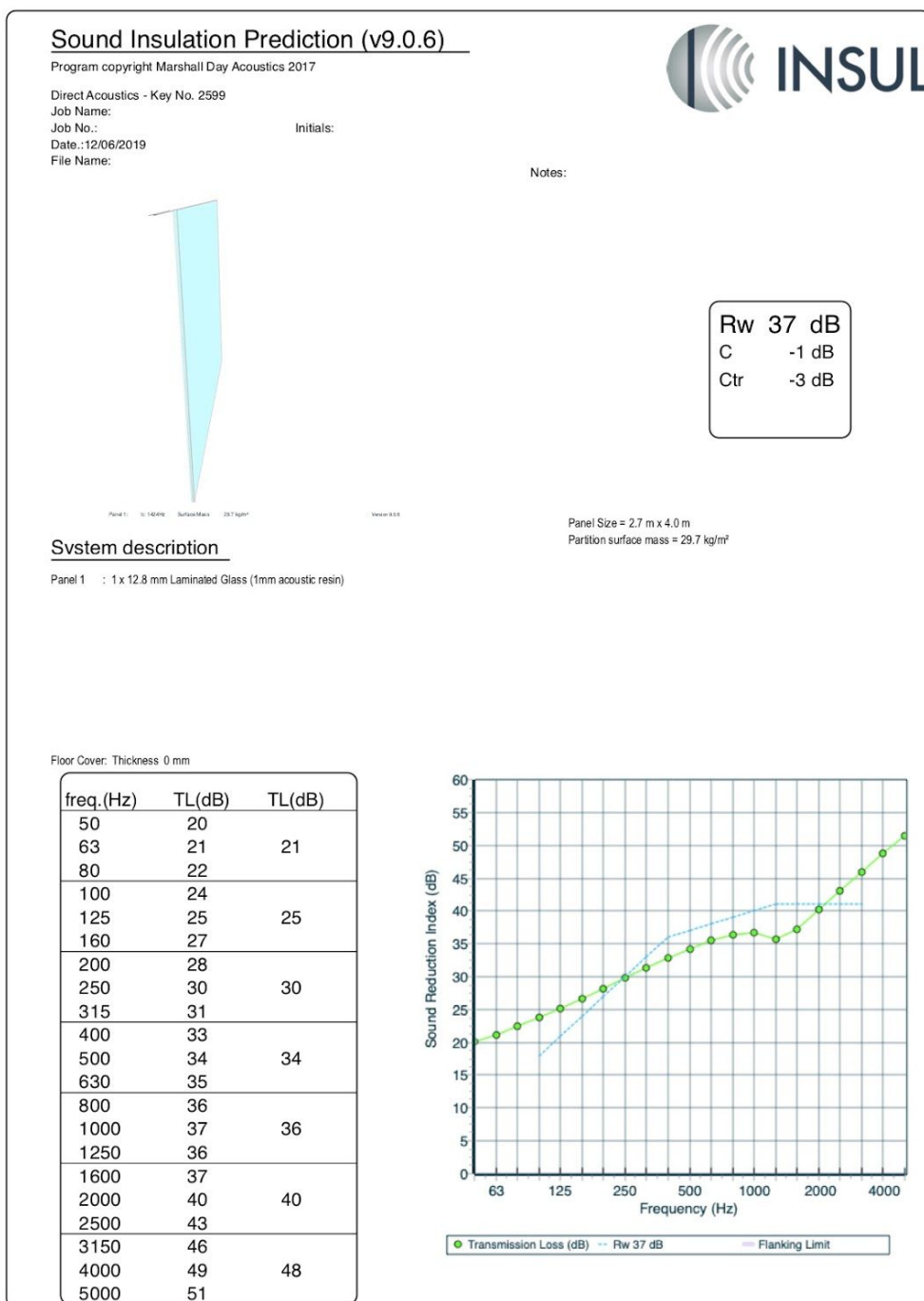


Figure 7

Absorption Coefficient

The attenuation design, whilst very effective, provides a relatively hard and reflective finished surface, which does not provide an ideal reverberation time of the enclosure.

To further improve upon the reverberant performance, 25mm melamine foam was applied to the internal of the space. Melamine is extremely effective, being 100% absorbent at high frequencies (1kHz-4kHz) and 50% absorbent between 125Hz-500Hz. Overall it can achieve an absorption coefficient of 0.8 (80%), ensuring that the specific troublesome frequencies do not resonate and cause further issues.

Real World Attenuation Data

Following the completion of the soundproof enclosure, Direct Acoustics undertook a monitoring exercise to establish the real world attenuation achieved on all axes.

The assessment was completed on Wednesday 26th June 2019 between 19:00 and 21:00 hours. All data was gathered with a live band (Name: Planet 80) in operation within the enclosure.

The set up consisted of:

- Zone Array - front of house PA;
- 2x 12 inch monitor speakers;
- Bass guitar with onstage cabinet;
- Guitar with onstage cabinet;
- Keyboard - directed into the main mix;
- Digital drum kit.

It should be noted that the data obtained was gathered whilst there were no guests present and therefore proposes a worst case scenario due to minimal acoustic absorption being obtained on the dance floor, which is a result of the reflective nature of the varnished hardwood dancefloor.

An NTI XL2 sound pressure level meter was used with a Type 1 microphone positioned 1.5 metres above local ground level. All relevant data obtained adheres to BS7445.

All monitoring equipment was calibrated pre and post measurements with no significant calibration drifts noted.

The temperature ranged between 16°C-17°C throughout our measurement period. Gusts of wind did occasionally peak beyond 5m/s, however pausing took place during measurements ensuring that relevant data was obtained.

Figure 8 below details the location measurements were obtained.

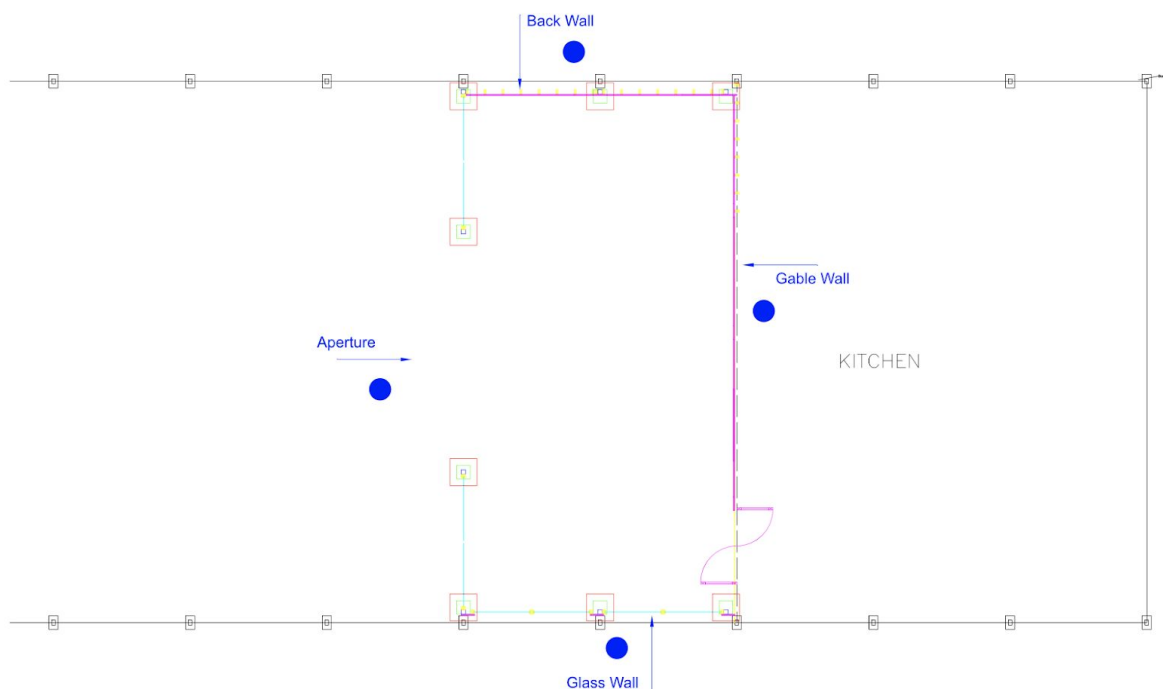


Figure 8

In order to calculate the attenuation provided, an average dance floor level of 96dB $L_{Aeq\ t1min}$ was established over a variety of songs. Direct Acoustics know this to be a realistic average volume level generated by bands over the course of a 45 minute set, when considering the acoustic properties of the enclosure. Figure 9 also contains an average of the low frequency content generated by the Zone Array.

Source	Location	LAeq	LZeq 63	LZeq 80	LZeq 100	LZeq 125	LZeq 160
Average Dance floor Level	Dance floor	96.0	83.0	77.3	96.0	98.6	88.1

Figure 9

Source	Location	LAeq	LZeq 63	LZeq 100	LZeq 125	LZeq 160
Average Dance floor Level	Back Wall	96.0	83.0	96.0	98.6	88.1
Average Back Wall Level	Back Wall	60.9	60.1	70.8	70.0	61.0
Average Attenuation	Back Wall	35.0	22.9	25.2	28.6	27.1

Figure 10

Source	Location	LAeq	LZeq 63	LZeq 100	LZeq 125	LZeq 160
Average Dance floor Level	Gable Wall	96.0	83.0	96.0	98.6	88.1
Average Gable Wall Level	Gable Wall	62.5	65	70.6	65.55	55.7
Average Attenuation	Gable Wall	33.5	18.0	25.4	33.1	32.4

Figure 11

Source	Location	LAeq	LZeq 63	LZeq 100	LZeq 125	LZeq 160
Average Dance floor Level	Glass Wall	96.0	83.0	96.0	98.6	88.1
Average Glass Wall Level	Glass Wall	62.2	63.7	70.2	70.1	59.8
Average Attenuation	Glass Wall	33.9	19.4	25.9	28.5	28.3

Figure 12

Considering the three axes that have been acoustically treated, the attenuation achieved follows a near identical trend. The broadspectrum level is significantly reduced by approximately 33dB - 35dB with the back wall where bands set up being marginally more effective.

When considering the low frequency generated on the dance floor, it is noted that the soundproof composite is least effective at 63Hz, with a minimum 18dB reduction. At 100Hz the attenuation is considerably increased providing a 25dB reduction on each axis.

At 125Hz and 160Hz the disparity between the attenuation of each wall composite increases, with the gable wall proving most effective (33dB and 32dB). The acoustic glass and back wall composite across these two frequencies follows a closer trend, with reductions of 28/27dB.

Source	Location	LAeq	LZeq 63	LZeq 100	LZeq 125	LZeq 160
Average Dance floor Level	Aperture	96.0	83.0	96.0	98.6	88.1
Average Aperture Level	Aperture	81.9	71.8	82.2	83.2	79.6
Average Attenuation	Aperture	14.2	11.3	13.9	15.5	7

Figure 13

Figure 13 demonstrates the attenuation gained 1m from the front of the 5m x 2m aperture facing into the marquee. There is a 14.2dB $L_{Aeq\ t1min}$ reduction within two metres of the dance floor. Low frequency at 63Hz, 100Hz, 125Hz and 160Hz is controlled by 11.3dB, 13.9dB, 15.5dB and 7dB $L_{Zeq\ t1min}$.

Heavyweight Acoustic Marquee Linings

In addition to the acoustic enclosure constructed at The Tournerville Woods Estate, Direct Acoustics have installed a 6.9kg/m² acoustic lining into two marquee bays adjoining the enclosure. This is to assist with attenuating and deflecting residual sound emitting from the 5m x 2m aperture, whilst also reducing patron noise.

On the 2nd November 2018, the specified acoustic lining underwent a UKAS accredited lab test to determine its frequency specific sound reduction index. The lab report can be seen on the following page.

SRL

**Test Report No: C/24219/T01****Page** 13 of 27**Date:** 13/11/2018

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Data Sheet 5

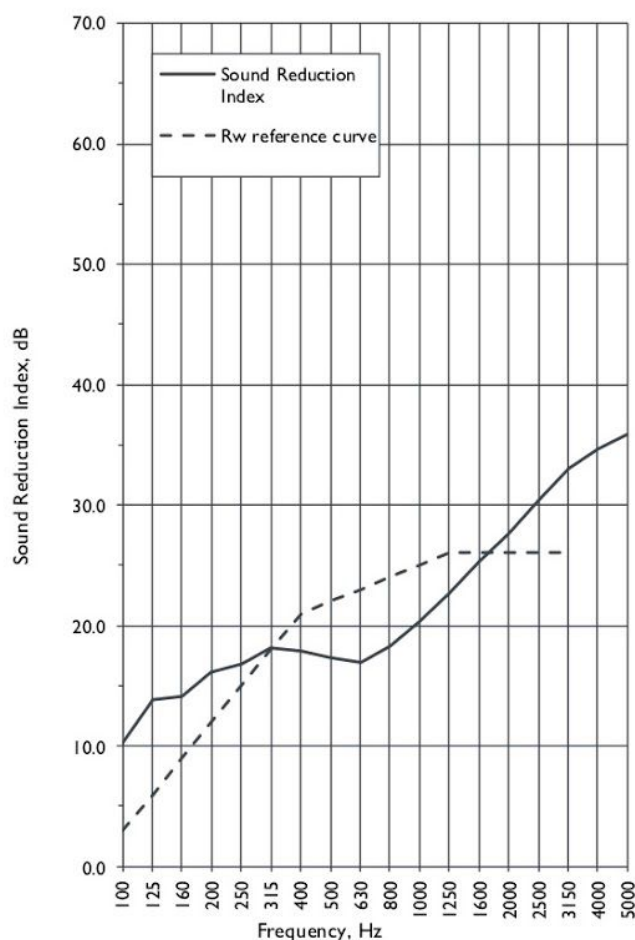
Test Number: 6
Client: Direct Acoustics
Test Date: 02/11/2018
Sample Height: 2.2 m
Sample Width: 2 m
Sample Weight: 6.9 kg/m²

Test Room: **Source** **Receiving**
Air Temperature: 11.8 °C 12.6 °C
Air Humidity: 61 % 57 %
Volume: 115 m³ 300 m³

Air Pressure: 1015 mbar

Product
Identification:

Freq, f Hz	Sound Reduction Index, dB	
	1/3 Oct	Octave
50+	14.3	11.3
63+	13.5	
80+	8.6	
100	10.2	12.4
125	13.9	
160	14.1	
200	16.1	16.9
250	16.8	
315	18.1	
400	17.9	17.3
500	17.3	
630	16.9	
800	18.3	20.1
1000	20.3	
1250	22.7	
1600	25.3	27.3
2000	27.7	
2500	30.4	
3150	33.1	34.4
4000	34.6	
5000	35.9	
6300+	36.8	37.2
8000+	36.9	
10000+	38.0	
Average 100-3150	19.9	Version v3.1



Rating according to BS EN ISO 717-1:2013

R_w(C;C_{tr})= 22 (-1 ; -3) dB

* shows measurement corrected for background

> shows measurement limited by background

+ shows Frequency beyond standard and not UKAS accredited

Figure 14

Mitigation - Monitoring Equipment

The Tournerbury Woods Estate has now purchased a class 2 Optimus Yellow CK152B Data Logging Sound Level Meter.

Considering the objective and subjective assessment undertaken on Wednesday 26th June 2019, Direct Acoustics recommend a suitable internal music noise level of 96dBA to not be exceeded on the dance floor.

The Tournerbury Woods Estate should use the sound pressure level meter to monitor visiting acts throughout each event to confirm that they are not exceeding this permitted volume level.

Conclusions

Since establishing themselves as a wedding venue, The Tournerbury Woods Estate have increasingly looked to manage their acoustic environmental impact through bespoke mitigation designs and management procedures.

Following an impact assessment carried out by Mr Owen Clingham BSc (Hons) MIOA FRSA of Auracle Acoustics, The Tournerbury Woods Estate commissioned Direct Acoustics to install a highly directional speaker system called a Zone Array during April 2014, enabling noise levels to meet pertinent acoustic criteria as stated by Mr Clingham.

The Zone Array proved extremely effective when visiting acts operated solely through the system, however with more live bands performing, additional control was required to contain the onstage equipment typically used during a live act.

As the first mitigation step, before a complete acoustic enclosure was installed, Direct Acoustics constructed an audio wall across the gable end of the marquee during June 2016. Real world testing details the following attenuation:

Source	Location	LAeq	LZeq 63	LZeq 100	LZeq 125	LZeq 160
Average Attenuation	Gable Wall	33.5	18.0	25.4	33.1	32.4

Figure 15

A full acoustic enclosure was constructed during April 2019 to further attenuate and steer amplified music generated by omnidirectional speakers or acoustic drum kits used by live acts away from noise sensitive receptors.

The enclosure consisted of:

- Mass Audio walls/ceiling to match the previously installed gable wall;
- Acoustic glass panels;
- Acoustic service doors to catering area;
- Melamine foam to reduce reverberation;
- Highly directional speaker system - Zone Array.

Monitoring Location	LAeq	LZeq 63	LZeq 100	LZeq 125	LZeq 160
Back Wall	35.0	22.9	25.2	28.6	27.1
Gable Wall	33.5	18.0	22.4	33.1	32.4
Glass Wall	33.9	19.4	25.9	28.5	28.3
Average	34.1	20.1	24.5	30.1	29.3

Figure 16

Figure 16 details the average attenuation achieved by the 3 walls of the structure that block direct line of site to any noise sensitive dwellings. Subjectively the reduced level of amplified music emitting out of the 2m x 5m aperture is not thought to be at a level to cause disturbance to nearby receptors.

It should be noted that of the approximate 50 events held at The Tournurbury Woods Estate per annum, 20% consist of live bands with the remainder being recorded music directly operated through the Zone Array. Therefore the acoustic performance of the structure outlined within this document represents a worst case scenario.

Images of the installed products can be seen in the appendix.

If there are any further questions on the systems used at The Tournurbury Woods Estate, please do not hesitate to get in touch.

Regards,

Direct Acoustics

Appendix

Installation Photographs













Glossary of Acoustic Terms

Decibel (dB): a unit of level derived from the logarithm of the ratio between the value of a quantity and a reference value. It is used to describe the level of many different quantities. For sound pressure level the reference quantity is 20 Pa, the threshold of normal hearing is in the region of 0 dB, and 140 dB is the threshold of pain. A change of 1 dB is only perceptible under controlled conditions.

dB(A): decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB(A) broadly agree with people's assessment of loudness. A change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound. The background noise level in a living room may be about 30 dB(A); normal conversation about 60 dB(A) at 1 metre; heavy road traffic about 80 dB(A) at 10 metres; the level near a pneumatic drill about 100 dB(A).

Hertz (Hz): unit of frequency, equal to one cycle per second. Frequency is related to the pitch of a sound.

$L_{A10,T}$: the A weighted level of noise exceeded for 10% of the specified measurement period (T). It gives an indication of the upper limit of fluctuating noise such as that from road traffic.

$L_{A10,18h}$: is the arithmetic average of the 18 hourly $L_{A10,1h}$ values from 06.00 to 24.00.

$L_{A90,T}$: the A weighted noise level exceeded for 90% of the specified measurement period (T). In BS 4142: 1990 it is used to define background noise level.

$L_{Aeq,T}$: the equivalent continuous sound level -the sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period (T).

$L_{Aeq,T}$: is used to describe many types of noise and can be measured directly with an integrating sound level meter. It is written as L_{eq} in connection with aircraft noise.

L_{Amax} : the highest A weighted noise level recorded during a noise event. The time weighting used (F or S) should be stated.

Additionally, the term SPL refers to the quantity Sound Pressure Level as discussed under Decibel (dB) above. This can be either a broad-band quantity including all octave-band figures or can refer to individual octave-bands for instance.

Additional terms within this proposal:

- MNL: Music noise level
- NSR: Noise sensitive receptor
- SAP: Structural acoustic panel