

Acoustic Associates Sussex Ltd

Planning Application Noise Assessment

Site: 'Roseland', The Causeway, Arundel
Client: Birchside Management Ltd

Report by: George Orton BEng(Hons) MIOA

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Issue 1



Acoustic Associates

ANC
THE ASSOCIATION OF
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1 Introduction

Acoustic Associates have been appointed to undertake an acoustic assessment of the proposed 'Roseland', The Causeway, Arundel Redevelopment. The assessment will be submitted as part of a planning application.

The development will extend an existing development by adding an extra floor level. The full development description has been copied into the next section.

The purpose of this assessment is to assess noise levels affecting the proposed noise sensitive receptors (NSRs). The following has been assessed:

- Noise from existing environmental/commercial sources close to proposed development

Noise levels have been measured at several locations close to where the proposed re-development will take place. The noise levels were measured (October 2017) as part of the planning condition assessment which was required for the existing development.

Noise propagation around the proposed development has been predicted using the computer program IMMI (Wolfel).

The noise levels for the day and the night time period have been assessed in terms of and following the guidelines of the documents listed below:

- World Health Organisation (WHO) - Guidelines for Community Noise 1999
- ISO9613 (Attenuation of sound during propagation outdoors) 1996
- BS8233 (Sound insulation and noise reduction for buildings) 2014
- BS4142 (2014) Method for rating industrial noise affecting mixed residential and industrial areas
- ProPG 2017
- Sussex Planning Guidance

Based on the measured and predicted noise levels it is considered that the planning application would not be refused on noise grounds.

2 Context and Noise Criteria

2.1 Site Description

The proposed development will add an additional floor to an existing building. The existing building is a 3 storey (Ground floor, 1st floor and room in roof top floor) block of residential dwellings.

The existing room in roof floor will be, in effect, lifted up a floor level with a new 2nd floor level built underneath.

The existing building gained planning in August 2017. As a result of planning conditions (for the existing development) a noise survey and assessment was completed. At the end of the project internal noise levels were also measured which demonstrated that the standard internal noise criteria had been achieved.

2.2 Sussex Planning Guidance

Based upon the "Planning Noise Advice Document: Sussex (2015)" document, it is recommended in this case that appropriate criteria are provided by:

- BS4142 (2014+A1:2019) Method for rating industrial noise affecting mixed residential and industrial areas
- BS8233 (Sound insulation and noise reduction for buildings) 2014
- World Health Organisation (WHO) - Guidelines for Community Noise 1999

Assessment methodology, predictions of building envelope sound insulation and calculations of noise propagation will follow the principles detailed within:

- ISO9613 (1996) Attenuation of sound during propagation outdoors
- BS8233 (Sound insulation and noise reduction for buildings) 2014

Reference is also made to the 2017 ProPG "Planning & Noise Document"

2.3 National Planning Policy Framework 2019

The National Planning Policy Framework (2019) defines the Government's planning policies for England and how these are expected to be applied. It sets out the Government's requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so.

The document recommends: *preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability.*

Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

- Mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;*
- Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason;*

Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed.

The Framework states that the planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of noise pollution. It does not, however, provide any specific formal guidelines.

2.4 BS8233 Noise Criteria

Table 5 of BS8233 provides the following guideline values:

Activity	Location	Time period of day	
		07:00-23:00	23:00-07:00
Resting	Living Rooms	35dB LAeq,16hour	-
Dining	Dining Room/Area	40dB LAeq,16hour	-
Sleeping (daytime resting)	Bedroom	35dB LAeq,16hour	30dB LAeq,8hour

Table 1: BS8233 Criteria

2.5 WHO Internal Noise Criteria

The target internal levels are based on guidelines laid out by the World Health Organisation (WHO) and are as follows:

Room Type	Target Maximum Internal Level - L_{Aeq} dB (A)
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Living rooms	35 (Daytime only)
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Bedrooms	30 (Night)
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Room Type	Maximum Internal Level – L_{Amax} dB(A)
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Bedrooms	45 (not more than 10-15 times per Night)
----------	--

The target maximum internal noise level for a bedroom during the night time corresponds to the threshold of sleep disturbance. WHO state that the noise level outside a bedroom window would be less than 45dB(A) this assumes that an open window provides 15dB attenuation.

2.6 WHO External Noise Criteria

With regard to outdoor amenity areas WHO states the following:

To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55dB(A) on balconies, terraces and in outdoor living areas.

To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 50dB(A) on balconies, terraces and in outdoor living areas.

2.7 BS4142(2014+A1:2019): Method for rating and assessing industrial and commercial sound

This document provides a means of assessing the impact of industrial or commercial sound upon nearby noise-sensitive receptors, including residential properties.

It does this by comparing the Rating Level of the noise from the industrial or commercial source with the pre-existent L_{90} background noise level affecting the same noise-sensitive premises. The Standard provides guidance that:

- Typically, the greater the difference, the greater the magnitude of the impact.
- A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background noise level, this is an indication of the specific sound source having a low impact, depending on the context.

2.8 ProPG –Planning and Noise: new residential development

The following has been copied from the Association of Noise Consultants' (ANC) website:

Over recent years, we have seen the introduction of the Noise Policy Statement for England, as well as substantial changes in national planning policy. But these developments have not been accompanied by detailed technical acoustic advice.

The lack of detailed guidance can lead to inconsistent application of policy, that may in turn result in unsatisfactory development and affect quality of life.

To fill that gap and facilitate efficient and consistent decision-making in the development control process, the Institute of Acoustics, the Association of Noise Consultants and the CIEH have joined to produce a Professional Practice Guidance (ProPG) focussing on noise sensitive development.

The following extract has been taken (Figure 2, Page 13) from the ProPG document:

ACTIVITY	LOCATION	INTERNAL NOISE LEVEL	INTERNAL NOISE LEVEL
Resting	Living room	35 dB $L_{Aeq,10hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,10hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,10hr}$	30 dB $L_{Aeq,8hr}$ 45 dB L_{max} (Note 4)

NOTE 1 The Table provides recommended internal L_{Aeq} target levels for overall noise in the design of a building. These are the sum total of structure-borne and airborne noise sources. Ground-borne noise is assessed separately and is not included as part of these targets, as human response to ground-borne noise varies with many factors such as level, character, timing, occupant expectation and sensitivity.

NOTE 2 The internal L_{Aeq} target levels shown in the Table are based on the existing guidelines issued by the WHO and assume normal diurnal fluctuations in external noise. In cases where local conditions do not follow a typical diurnal pattern, for example on a road serving a port with high levels of traffic at certain times of the night, an appropriate alternative period, e.g. 1 hour, may be used, but the level should be selected to ensure consistency with the internal L_{Aeq} target levels recommended in the Table.

NOTE 3 These internal L_{Aeq} target levels are based on annual average data and do not have to be achieved in all circumstances. For example, it is normal to exclude occasional events, such as fireworks night or New Year's Eve.

NOTE 4 Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,10}$, depending on the character and number of events per night. Sporadic noise events could require separate values. In most circumstances in noise-sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB $L_{Amax,10}$ more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability and regularity of noise events (see Appendix A).

NOTE 5 Designing the site layout and the dwellings so that the internal target levels can be achieved with open windows in as many properties as possible demonstrates good acoustic design. Where it is not possible to meet internal target levels with windows open, internal noise levels can be assessed with windows closed, however any facade openings used to provide whole dwelling ventilation (e.g. trickle ventilators) should be assessed in the "open" position and, in this scenario, the internal L_{Aeq} target levels should not normally be exceeded, subject to the further advice in Note 7.

NOTE 6 Attention is drawn to the requirements of the Building Regulations.

NOTE 7 Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal L_{Aeq} target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved. The more often internal L_{Aeq} levels start to exceed the internal L_{Aeq} target levels by more than 5 dB, the more that most people are likely to regard them as "unreasonable". Where such exceedances are predicted, applicants should be required to show how the relevant number of rooms affected has been kept to a minimum. Once internal L_{Aeq} levels exceed the target levels by more than 10 dB, they are highly likely to be regarded as "unacceptable" by most people, particularly if such levels occur more than occasionally. Every effort should be made to avoid relevant rooms experiencing "unacceptable" noise levels at all and where such levels are likely to occur frequently, the development should be prevented in its proposed form (see Section 3.D).

Figure 2. ProPG Internal Noise Level Guidelines (additions to BS8233:2014 shown in blue)

Figure 1: ProPG Guidance

3 Unattended Noise Survey Baseline Conditions and Results

An unattended noise survey was carried out from the 29/09 to the 04/10 2017 in order to measure Road/Rail noise levels affecting the proposed development. Noise measurements were conducted on top of the site hoarding fence (prior to the construction of the original development).

The noise monitoring locations can be seen in the survey noise models found in the appendix.

3.1 Baseline Conditions

- Survey carried out by: George Orton BEng (Hons) MIOA
- Equipment used: Castle Mirus - Type 1 Sound Level Meter
- Weather conditions: Variable (showers); Wind: variable direction
Probable gusts in excess of 5ms⁻²

Meters were calibrated before and after commencing the noise measurements (@94dB no drift).

The microphone was approximately 3.5m from the ground and well away from any other reflective surfaces with the exception of the fence below.

As the reflective surface was not behind the microphone the results will be classified as freefield. This may result in noise levels that are marginally higher than a true freefield value.

All noise levels in the report, including those predicted by the noise model, will be free-field unless stated otherwise.

3.2 Noise Survey Results

At this position the dominant noise source is the road (see next sections). The survey data has been used to calculate the 16hr day time and the 8hr night time period noise levels:

Date 2017	Day	Freefield dBA	
		L _{Aeq} 07:00-23:00hrs	L _{Aeq} 23:00-07:00hrs
29/09	Friday	-	52.1
30/09	Saturday	57.3	52.3
01/10	Sunday	57.9	53.8
02/10	Monday	59.7	54.5
03/10	Tuesday	59.4	54.8
Average all		59	54
Average weekdays		60	55

Table 2: Unattended Noise Survey Levels

4 Rail Noise Survey Baseline Conditions and Results

Attended rail noise measurements were also conducted on the 04/10/2017.

4.1 Baseline Conditions

- Survey carried out by: George Orton BEng (Hons) MIOA
- Equipment used: Norsonic - Type 1 Sound Level Meter
- Weather conditions: Dry; Wind: Gusts up to around 5ms⁻²

Meters were calibrated before and after commencing the noise measurements (@94dB no drift). The microphone was approximately 1.5m from the ground and well away from any other reflective surfaces I.E. free field. All noise levels in the report, including those predicted by the noise model, will be free-field unless stated otherwise. The chosen location was closer to the railway line (see appendix) in order to measure railway noise levels in absence of extraneous noise sources (Road noise).

4.2 Rail Noise Survey Results

Short measurements were completed for various train pass-by events. The measurements were started when the train noise was audible and finished when the train passed by and was inaudible. These measurements will be used to aid with the completion of the computer noise model.

The results can be seen in the table below:

Train Type	Freefield dBA		
	L _{Aeq}	L _{Amax}	SEL
North Stop	66	79.6	84.4
South No Stop	76.8	85.9	89.3
South Stop	67.7	72.7	85.5
North No Stop	78.3	84.7	88.1

Table 3: Rail Noise Survey Levels

5 Prediction of Rail Noise

In order to calibrate the noise model the day and night time rail noise levels will be predicted.

5.1 Methodology

The noise levels for the day and night time periods have been predicted, using on site measurements, rather than measuring constantly for 24hrs or more. The predictions have been made using the following information:

- Current time table data which details the number of passenger trains that pass by the site.
- Train Sound Exposure levels were measured on site during the day time. These individual measurements were then grouped into train types based direction and whether they stopped at the station or not.

The above is in accordance with Calculation of Rail Noise 1995 which states the following in section 43 paragraph 2 and 3.

“In order to determine the $L_{Aeq,16h}$ or $L_{Aeq,8h}$ noise level it may be necessary to carry out SEL noise measurements of each train pass-by over the full time period of interest. Exceptions to this may occur when the train mix and speed of individual train types remain reasonably constant over the relevant time period. For this situation, it is acceptable to measure a representative sample of individual train pass bys of each train type running on each track and determine an arithmetic mean value for the SEL for each case.”

In paragraph 3 CRN goes on to say that having established by measurement the mean values for the SELs of each train type operating on the railway, the day and the night time noise levels ($L_{Aeq,16hr}$ and $L_{Aeq,8h}$) should be calculated using a formula that is also stated in CRN. The SEL to $L_{Aeq,day/night}$ formula is detailed below and implemented in section 4.

For each train type: $L_{Aeq} = SEL - 10\log T + 10\log N$

- $N =$ no. of events in period (For each train type based upon timetable information)
- $T =$ no. of seconds in period (57600 seconds for the day and 28800 for the night)

It should be noted that a train SEL measured in the daytime is likely to be marginally higher than if an identical train SEL was measured at night time. This is due to the fact that in the daytime the background noise levels are generally higher than at night time and during the train SEL measurement background noise will be “captured” as well as the train noise.

The predicted day and night time noise levels at the survey position have been used to calibrate a noise model (section 6) which predicts noise levels around the whole of the proposed development.

5.2 Rail Noise Prediction at Closest Survey Point

The train table has been reviewed and in general for the day time there will be 2 trains per hour, in each direction, that stop at the station. In general for each stopping train there is also a non-stopping train (trains join or split at Horsham).

For the night time period 6 trains stop at the station on the way to London (North) and 4 trains stop on the way from London (south). Again it is assumed that there will be the same number of non-stopping trains as there is stopping trains.

In paragraph 3 CRN states that having established, by measurement, the mean values for the SELs of each train type operating on the railway, the day and the night time noise levels ($L_{Aeq,16hr}$ and $L_{Aeq,8h}$) can be calculated. The day and the night time period noise level relating to each train type can be calculated using the following formula

$$\text{Train Type } L_{Aeq, \text{day/night}} = \text{SEL} - 10\log T + 10\log N$$

- N = no. of events in period (For each train type based upon timetable information)
- Day = 07:00-:23:00hrs & Night = 23:00-07:00hrs

T = no. of seconds in period (57600 seconds for the day and

The tables below show the predicted noise levels at the survey position:

Train Type	SEL	N	$L_{Aeq, \text{day}}$
North Stop	84.4	32	52
South Stop	85.5	32	53
North no stop	88.1	32	56
South no stop	89.3	32	57
Total $L_{Aeq, \text{day}}$			61

Table 4: Day Time Rail Noise Level

Train	SEL	N	$L_{Aeq, \text{night}}$
North Stop	84.4	6	45
South Stop	85.5	4	44
North no stop	88.1	6	48
South no stop	89.3	4	48
Total $L_{Aeq, \text{night}}$			53

Table 5: Night Time Rail Noise Level

5.3 Non Passenger Train Activity

The effect of noise from night time freight train activity is sometimes difficult to assess due to irregularity of freight operations and the non-existence of any useful timetable information. However reference can be made to the Network Rail freight services map (from their Sussex Route Utilisation Strategy RUS (shown in appendix) which demonstrates that there are no timetabled freight trains that operate to the East of Chichester. There is a limited freight service between Chichester and Westbury (Near Yeovil). Network rail state that the south coast railway lines are capable of taking freight traffic however the high number of passenger trains makes it impractical.

There may well be occasional leaf clearing or maintenance trains that operate during the day or night-time period. These trains will be seasonal/infrequent and it is very unlikely that there would be several in a week let alone more than one in any night time hour.

6 Computer Noise Model

In order to see how noise varies at different positions around the proposed development it is possible to produce a noise contour map.

A computer noise model has been completed using the computer package IMMI. The survey data and drawings of the proposed development have been used to complete the noise models. IMMI faithfully implements the propagation method of ISO-9613:1996; Acoustics – Attenuation of sound during propagation outdoors.

6.1 Survey Model Methodology

An “existing site” noise model was completed first to allow the calibration of the noise sources. Nearby buildings were added to the model.

Reception Points (RP)s were added to the model in the location of the two noise survey microphones (RPs predict the noise level at a particular height/position within the model)

Initially the railway line was added as a line noise source and the sound power (day/night) was adjusted so the Rail RP matched the average values in tables 4 & 5. Rail noise source was added first as the survey position was closer to the source and the methodology (SEL) measurements meant that there would have been less affect from extraneous noise sources.

The road noise line source was then added to the model (on elevated section of model as the road gains height as it passes over the railway bridge)

The sound power (day/night) was adjusted so the unattended survey RP matched the average values in table 2 (to predict worst case the higher weekday average was used). The survey models can be seen in the appendix of the report.

6.2 Travis Perkins Yard

There is also a small builder's merchant at a distance of 120m to the South West of the proposed development. Travis Perkins have confirmed the open from 07:00-17:00hrs and would have deliveries between these hours. The sporadic traffic to the yard is discussed later on in the report. During the visits to site no noise was audible from the yard. However to err on the side of caution the noise from a fork lift reverse beacon will be added to the model. This noise source would be the most likely noise source to be audible at the development given the distance.

Previous surveys have measured the noise from forklift beacons at a level of 66/67dBA at 10m. A medium duty beacon will have a noise level of approximately 92dBA at 1m (this is louder than the survey results). Assuming the worst case (test in anechoic room) the sound power would be approximately 103dBA. A conservative estimate is that the beacon will be on continuously for 15minutes per hour for 8 consecutive hours in the day (120mins total). Therefore for the whole of the day the on-time corrected sound power would be 9dB lower (94dBA).

6.3 Final Noise Model

The forklift truck noise was added to the model along with the proposed (extended) development building. Additional RPs were added outside bedroom and lounge windows in the new sections of the development.

The 1st floor daytime contour plot can be seen below:

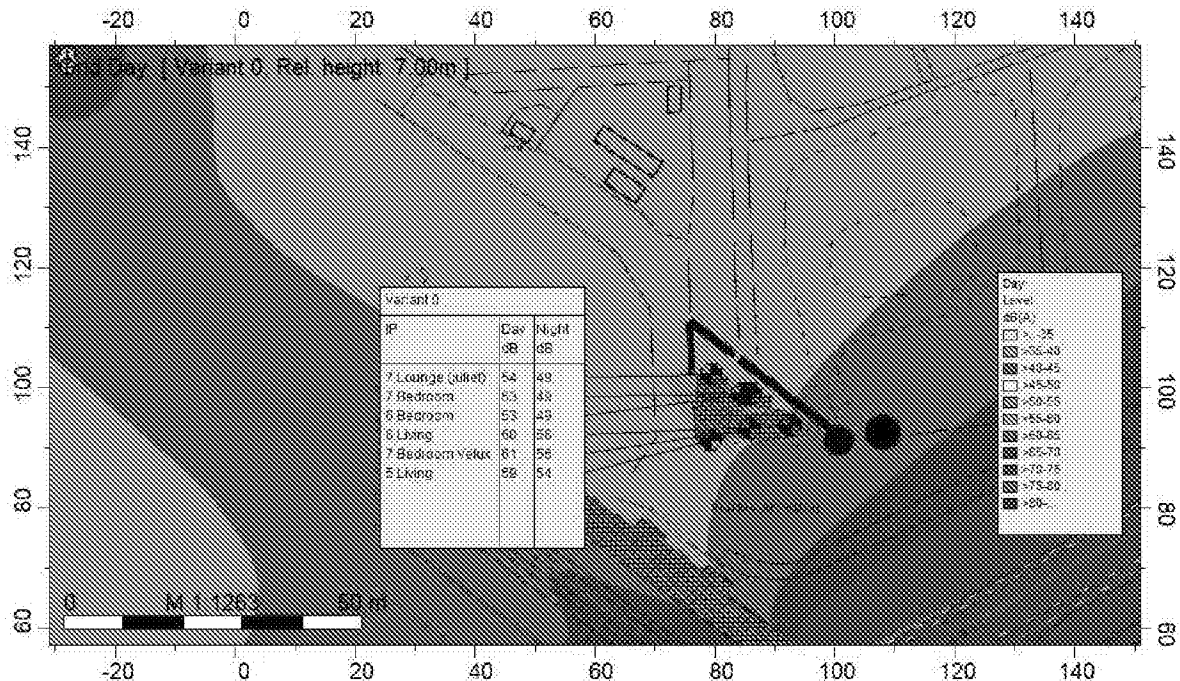


Figure 2: Noise Contour Plot

The Forklift Truck only model can be seen below:

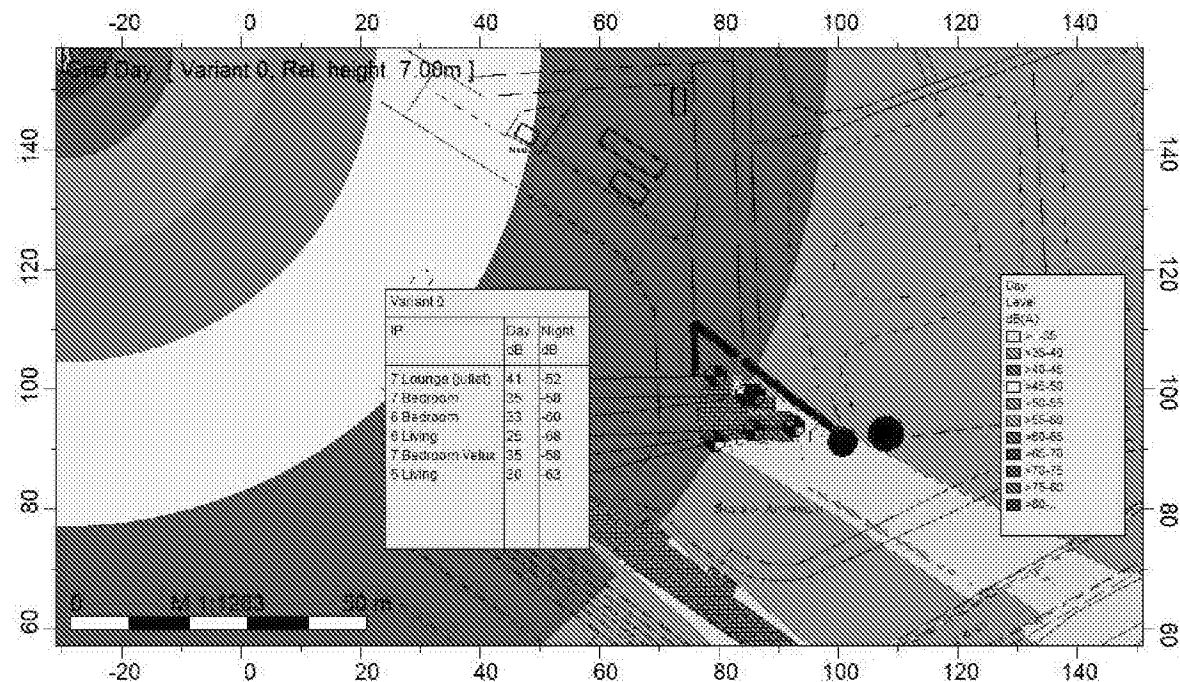


Figure 3: Forklift Reversing Model

7 Required Sound Insulation of Building Envelope

The noise model predictions have been used to demonstrate minimum building envelope sound reduction (SRI) required so that the BS8233 criteria can be achieved.

Model Position	External Noise Level	Target	ReqSRI
7 Lounge (Juliet)	54	35	19
7 Bedroom	49	30	19
7 Bedroom Velux	56	30	26
6 Bedroom	49	30	19
6 Lounge	60	35	25
5 Lounge	59	35	24

Table 6: Required SRI

7.1 BS8233 Calculations

The BS8233 "Rigorous Calculation" has been used to predict the sound insulation provided by the building envelope (Calculation detailed in BS8233 (6.7.2) and full details of the calculations can be found in the appendix of the report. The calculation was completed for bedrooms and lounge areas on different facades of the development.

The calculation has been used to specify required acoustic performance of glazing. For the calculation tests results from Velfac were used which took into account the frame and the glazing.

Standard trickle vent and Simon Rw trickle vent data has also been used as it is understood that trickle vents be installed within all plots (Either System 1 or System 3 ventilation as detailed in ADF). Velfac have test results for their windows and glazing together. Other installers may have test results for the glazing (Saint Gobain, Pilkinton Etc.) only.

7.2 LAmax Bedrooms

L_{Amax} levels were also measured during the noise survey. The noise model shows that the worst case noise level (outside bedroom) is 1dB higher than the noise level at the survey position. The survey data was recorded in (consecutive) 5 minute measurements.

The survey data was used to predict for a typical night time there will be no more than 10* L_{Amax} events, per night, over 45dBA inside if the building SRI is 26dBA (required SRI of building envelope to achieve 23:00-07:00hrs criterion). The above would easily achieve the WHO Guidelines for community noise (1999) criteria.

** 10 in a night was worst case prediction (night 5) for other nights the number over 45dB ranged from 2-8)*

7.3 Glazing and Ventilator Specifications

The table below should be used by window suppliers/installers who have acoustic test just the glass that will be fitted within a frame:

Room	Glazing Only Rw+Ctr ¹	Vent Dnew ²	ReqSRI	BS8233 CalcSRI
Bedrooms	30dB	28dB	19	25
Lounges	30dB	33dB	25	27
Velux (Roof)	30dB	30dB	26	27

Table 7: BS8233 Calculations Window/Frame Test Results

¹ The glazing performance in the table above has been specified in terms of Rw+Ctr (sometimes referred to as Rtraffic). The required Rtraffic levels should be achieved by the glazing on its own.

7.4 Ventilator Corrections

²The Dn,e,w in the table relates to performance for all ventilators for that room for example:

- 1 ventilator required d Dn,e,w = 28dB
- 2 ventilator required d Dn,e,w = 31dB
- 4 ventilator required d Dn,e,w = 34dB

(I.e. Dn,e,w+10LogN where N is number of ventilators)

7.5 On Site Internal Noise Measurements

For the existing development Worthing Glass supplied and installed glazing and trickle vents. To satisfy a planning condition an internal noise survey was completed prior to occupation. The internal noise levels, in unfurnished rooms with ventilators open, were all lower than the BS8233 criteria.

It is understood that the proposed new sections of the development will probably have the same glazing/ventilator specification as the existing development (as they have been proven to be acceptable)

8 Discussion and Uncertainty

8.1 Dominant Noise Source

Whilst on site it was subjectively noted that the road noise was the dominant noise source affecting the proposed development. The road has a steady stream of traffic during the day and the night. The train noise is clearly audible at the development site but there are gaps between the train pass-bys. Train station announcements are only very faintly audible at the position of the proposed development.

8.2 Model Uncertainty

The noise model was simplified to include only the A27 road and railway noise sources. The model was calibrated by taking measurements close to the railway line and using a calculation method which eliminates the effect of extraneous noise sources.

A further forklift truck point source was also added to the model based on the sound pressure level as stated in a catalogue. This level was higher than measured in two previous assessments completed by Acoustic Associates.

The noise model did not include a noise source for the traffic that passes the site to the station or to the Builder's Merchant. However the noise created by these traffic movements is likely to be significantly lower than the noise created by the A27 (significantly higher numbers of faster moving vehicles on the A27 compared to the station access road). The model was also completed using the worst case weekday average levels from the survey.

However the noise survey would have picked up the noise created by the vehicles accessing the station and the Builder's Merchants. The noise model was completed based on the levels for the noise survey which would have captured all noise sources. Therefore the noise model predicted levels should be accurate as the development front façade will be exposed to noise levels created by the road and the access road.

8.3 BS4142

The planning condition does not mention BS4142 however for completeness the assessment methodology has been briefly followed. The graph in the appendix shows that for a working day (last 2 days) the representative background noise level would be at least 55dBA. The noise model was used to predict that for the worst case receptor (7 Lounge Juliet window) the noise created by the forklift was 41dBA. Even with a tonal correction and a contribution from the sporadic traffic pass-bys to the builders yard the noise rating level will not be higher than the background noise level.

9 Conclusion

The proposed development will add an additional floor to an existing building. The existing building is a 3 storey (Ground floor, 1st floor and room in roof top floor) block of residential dwellings.

The existing room in roof floor will be, in effect, lifted up a floor level with a new 2nd floor level built underneath.

Noise levels have been measured where the proposed development will be built. Additional measurements have also been completed close to the nearby railway.

Noise levels created by the A27 road, the railway and Travis Perkins forklifts have been assessed. The noise sources have been added to a noise model which predicts the noise levels that will affect the development.

The development has implemented good acoustic design principles by locating bedrooms on the quieter rear façade (the exception being the room in roof bedroom which has small windows in the building's roof which do not directly face the road due to the angle of the roof).

9.1 Internal Noise Levels

If the noise mitigation measures detailed in section 7 are implemented the internal noise levels would easily achieve the BS8233 noise criteria detailed in section 2.

Achieving these criteria will result in a good acoustic environment inside the proposed dwellings.

It is considered that the planning application would not be refused on noise grounds so long as the mitigation measures are completed by the developer prior to occupation of the building.

10 Appendix

10.1 Noise Models

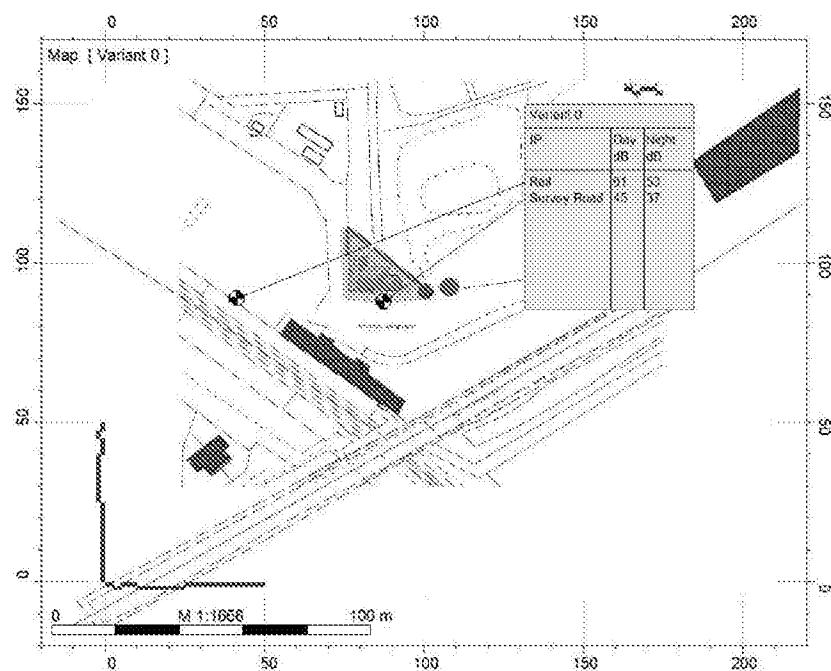


Figure 4: Rail Survey Noise Model

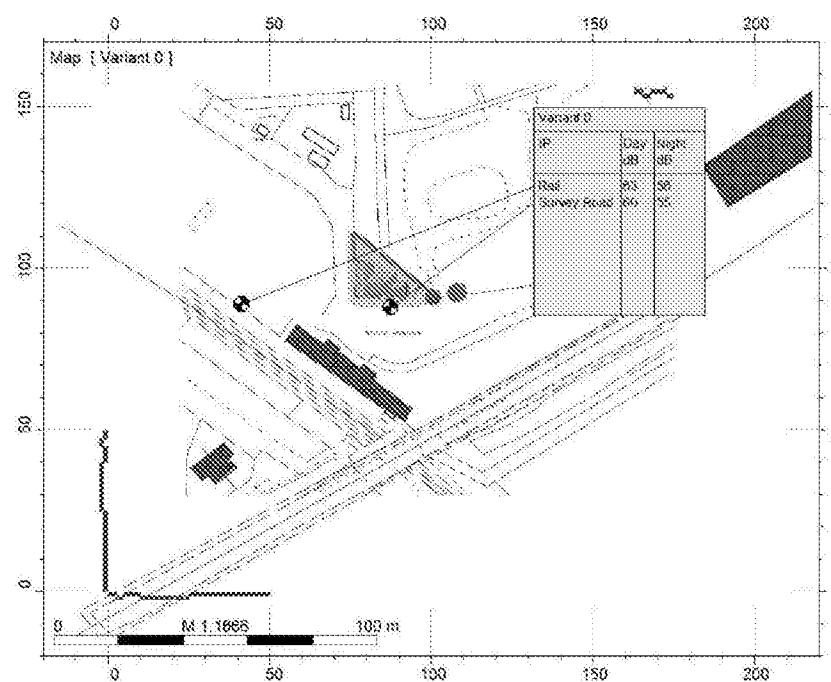


Figure 5: Rail & Road Survey Noise Model

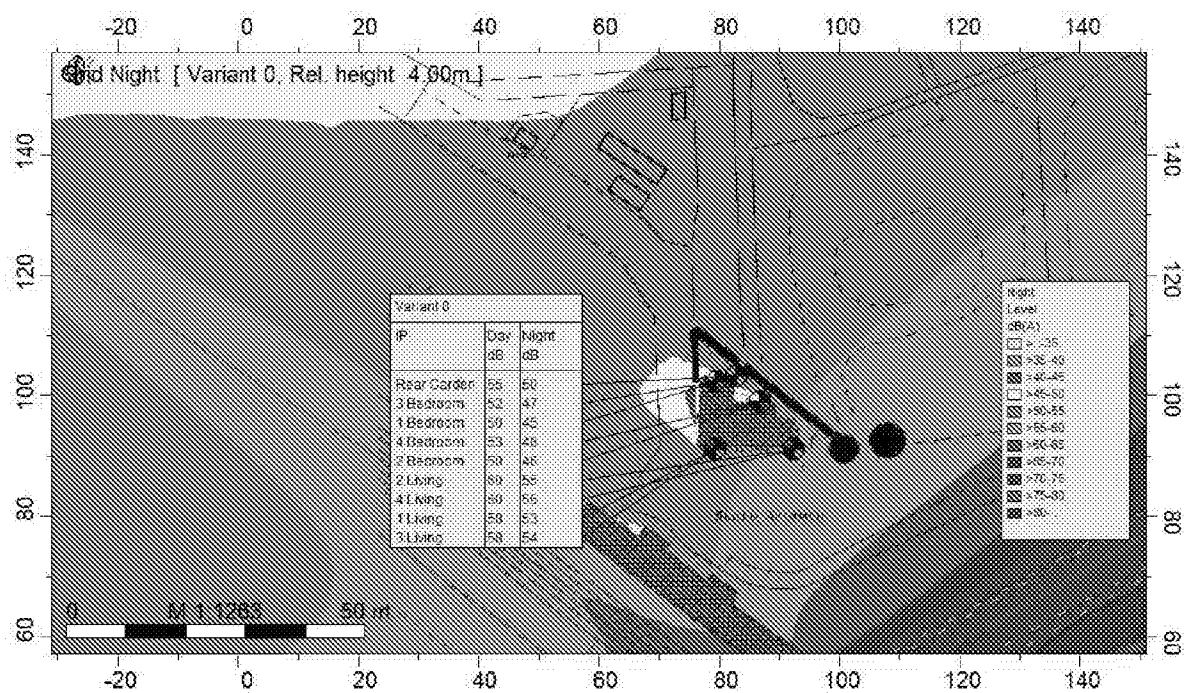


Figure 6: Night-time Noise Model

10.2 SRI Calculations

Non-Frequency Dependent Variables			Key for Table Below	
Term	Derivation	Value		
A_0	Given in BS EN 20140-10 = 10 (m ²)	10	R_{wi}	Sound Reduction of Window (Octave)
S_r	Total Facade Area (m ²)	10	R_{ew}	Sound Reduction Index of External Wall (Octave)
S_{wi}	Window Area (m ²)	1.9	R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
S_{ew}	External Wall Area (m ²)	8.1	A	Equivalent Absorption Area of Rx Room
S_{rr}	Ceiling Area (m ²)	0.00001	$D_{tr,e}$	Insulation of Trickle Vent (BS EN 20140-10)
S	Total Area sound enters the room (m ²)	10		

Frequency Dependent Variables							
Term	Description	Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
$L_{eq,ff}$	Free-Field External Noise Level (from survey)	55.16	52.02	51.29	52.86	48.09	38.44
$D_{tr,e}$	Typical Trickle Vent predicted to be DnEw28	35	31	30	26	27	32
R_{wi}	Velfac 6/24/6	13.2	22.2	34.1	37.9	32.6	41.9
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	40	39	44	52	60	65
R_{rr}	No Roof	100	100	100	100	100	100
A	Equivalent Absorption Area of Room (BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details							
Term From Equation Below	Octave Band Centre Frequency						
	125	250	500	1000	2000	4000	
$L_{eq,ff}$	55.16	52.02	51.29	52.86	48.09	38.44	
$A_0/S \cdot 10^{(-D_{tr,e}/10)}$	0.0003162	0.000794	0.001	0.002511886	0.001995262	0.000630957	
$S_{wi}/S \cdot 10^{(-R_{wi}/10)}$	0.009094	0.001145	7.39E-05	3.08144E-05	0.000104413	1.22674E-05	
$S_{ew}/S \cdot 10^{(-R_{ew}/10)}$	0.000081	0.000102	3.22E-05	5.11075E-06	0.00000081	2.56144E-07	
$S_{rr}/S \cdot 10^{(-R_{rr}/10)}$	1E-16	1E-16	1E-16	1E-16	1E-16	1E-16	
$10 \log_{10}(S/A) + 3$	2.5860731	1.53872	0.9588	0.958800173	1.239087409	1.239087409	
$L_{eq,2}$	37.518729	26.65554	22.6881	27.87670972	22.55235552	7.766109611	
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1	
A-Weighted L_{eq}	21.418729	18.05554	19.4881	27.87670972	23.75235552	8.766109611	

Predicted Building Envelope SRI	25	Velfac 6/24/6
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BS8233 Calculation can be seen below:							
$L_{eq,2} = L_{eq,ff} + 10 \log_{10} \left(\frac{A_0}{S} 10^{\frac{-D_{tr,e}}{10}} + \frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{\frac{-R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$							

Figure 7: Bedroom Solution

Non Frequency Dependent Variables			Key for Table Below	
Term	Derivation	Value	R _{wi}	Sound Reduction of Window (Octave)
A ₀	Given in BS EN 20140-10 = 10 (m ²)	10	R _{ew}	Sound Reduction Index of External Wall (Octave)
S _t	Total Facade Area (m ²)	14.5	R _{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
S _{wi}	Window Area (m ²)	4.5	A	Equivalent Absorption Area of Rx Room
S _{ew}	External Wall Area (m ²)	10	D _{tr,e}	Insulation of Trickle Vent (BS EN 20140-10)
S _{rr}	Ceiling Area (m ²)	0.00001		
S	Total Area sound enters the room (m ²)	14.5		

Frequency Dependent Variables							
Term	Description	Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}	Free-Field External Noise Level (from survey)	55.16	52.02	51.29	52.86	48.09	38.44
D _{tr,e}	Simon Frame Vent 33dB	40	36	35	31	32	37
R _{wi}	Velfac 6/24/6	13.2	22.2	34.1	37.9	32.6	41.9
R _{ew}	Cavity Masonry (Brick Cavity with insulation lightweight block)	40	39	44	52	60	65
R _{rr}	No Roof	100	100	100	100	100	100
A	Equivalent Absorption Area of Room (BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
Term From Equation Below	Octave Band Centre Frequency					
	125	250	500	1000	2000	4000
L _{eq,ff}	55.16	52.02	51.29	52.86	48.09	38.44
A ₀ /S . 10 ⁴ (-D _{tr,e} /10)	6.897E-05	0.000173	0.000218	0.000547813	0.000435143	0.000137604
S _{wi} /S . 10 ⁴ (-R _{wi} /10)	0.014854	0.00187	0.000121	5.0332E-05	0.000170547	2.00375E-05
S _{ew} /S . 10 ⁴ (-R _{ew} /10)	6.897E-05	8.68E-05	2.75E-05	4.35143E-06	6.89655E-07	2.18088E-07
S _{rr} /S . 10 ⁴ (-R _{rr} /10)	6.897E-17	6.9E-17	6.9E-17	6.89655E-17	6.89655E-17	6.89655E-17
10log ₁₀ (S/A)+3	4.1997532	3.1524	2.57248	2.572480196	2.852767432	2.852767432
L _{eq,2}	41.117785	28.45437	19.50174	23.22825867	18.77028692	3.277151976
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted L _{eq}	25.017785	19.85437	16.30174	23.22825867	19.97028692	4.277151976

Predicted Building Envelope SRI	27	Velfac 6/24/6
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BS8233 Calculation can be seen below:

$$L_{eq,2} = L_{eq,ff} + 10 \log_{10} \left(\frac{A_0}{S} 10^{\frac{-D_{tr,e}}{10}} + \frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{\frac{-R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

Figure 8: Lounge Solution

Non Frequency Dependent Variables			Key for Table Below	
Term	Derivation	Value	R_{wi}	Sound Reduction of Window (Octave)
A_0	Given in BS EN 20140-10 = 10 (m ²)	10	R_{ew}	Sound Reduction Index of External Wall (Octave)
S_r	Total Facade Area (m ²)	7	R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
S_{wi}	Window Area (m ²)	0.8	A	Equivalent Absorption Area of Rx Room
S_{ew}	External Wall Area (m ²)	0.00001	$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)
S_{rr}	Ceiling Area (m ²)	6		
S	Total Area sound enters the room (m ²)	7		

Frequency Dependent Variables							
Term	Description	Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
$L_{eq,f}$	Free-Field External Noise Level (from survey)	55.16	52.02	51.29	52.86	48.09	38.44
$D_{n,e}$	2xSimon Frame Vent 33dB	37	33	32	28	29	34
R_{wi}	Velfac 6/24/6	13.2	22.2	34.1	37.9	32.6	41.9
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	40	39	44	52	60	65
R_{rr}	Tile on Felt, Pitched Roof, 100mm mineral wool on plasterboard ceiling	43	43	43	43	43	43
A	Equivalent Absorption Area of Room (BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details							
Term From Equation Below		Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
$L_{eq,f}$		55.16	52.02	51.29	52.86	48.09	38.44
$A_0/S \cdot 10^{(-D_{n,e}/10)}$		0.000285	0.000716	0.000901	0.002264133	0.001798465	0.000568725
$S_{wi}/S \cdot 10^{(-R_{wi}/10)}$		0.0054701	0.000689	4.45E-05	1.8535E-05	6.28047E-05	7.37891E-06
$S_{ew}/S \cdot 10^{(-R_{ew}/10)}$		1.429E-10	1.8E-10	5.69E-11	9.01368E-12	1.42857E-12	4.51754E-13
$S_{rr}/S \cdot 10^{(-R_{rr}/10)}$		4.296E-05	4.3E-05	4.3E-05	4.29589E-05	4.29589E-05	4.29589E-05
$10 \log_{10}(S/A) + 3$		1.0370535	-0.0103	-0.59022	-0.590219426	-0.30993219	-0.30993219
$L_{eq,2}$		33.829321	23.61417	20.65192	25.9314177	20.57733041	6.049077132
A-Weighting		-16.1	-8.6	-3.2	0	1.2	1
A-Weighted L_{eq}		17.729321	15.01417	17.45192	25.9314177	21.77733041	7.049077132

Predicted Building Envelope SRI	27	Velfac 6/24/6
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BS8233 Calculation can be seen below:	
$L_{eq,2} \approx L_{eq,f} + 10 \log_{10} \left(\frac{A_0}{S} 10^{\frac{-D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{\frac{-R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$	

Figure 9: Velux Bedroom Solution

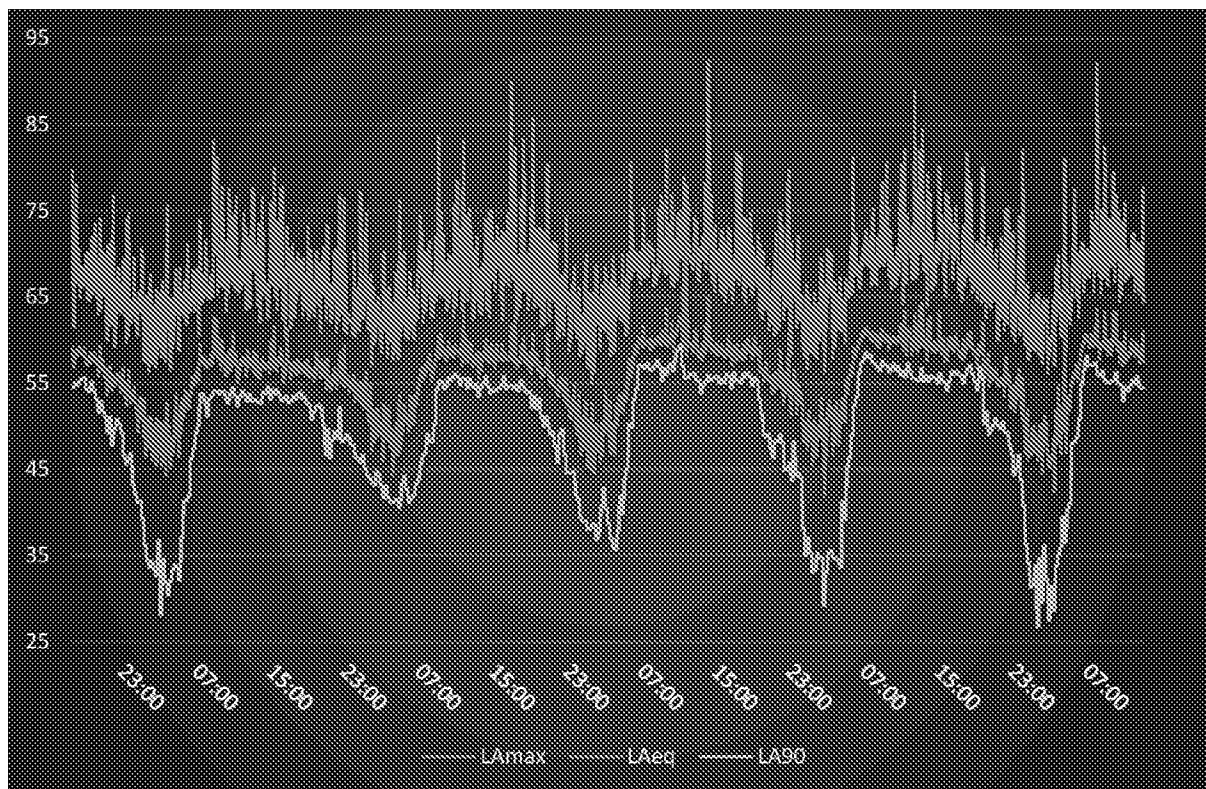


Figure 10: Unattended survey graph