



Azymuth Acoustics UK

Professional Acoustic Services

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Planning Noise Assessment Report

Ref: AA0168

Mixed Use Development

Oakfield Terrace

Anfield

Liverpool

For

Urbed

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1.0 Introduction

Azymuth Acoustics UK was appointed by URBED (Urbanism Environment and Design Ltd) to provide an environmental noise assessment in relation to a proposed residential/commercial development on Oakfield Road, Anfield, Liverpool.

The project proposes the conversion of 9 terrace houses into a mixed residential / commercial development which will include: 4no. houses and 4no. apartments together with multiple commercial units (including a micro-brewery / multi-functional space). It is proposed that the existing bakery will be extended into existing house number 195 - to provide a training space/ additional seating space and some staff facilities (an office, a WC and a staff room). Other commercial units will occupy the ground floor of existing plots 179 – 195. The proposed development is situated approx. 85m from Anfield Football Stadium.

This report is intended to provide information relating to potential noise levels affecting the site as required by Liverpool Council to support the detailed planning application. In particular the report sets out the following details:

- The results of a baseline noise survey undertaken at the proposed development site.
- The appropriate assessment criteria and guidance relating to noise in the environment as associated with this kind of development.
- An assessment of the appropriate level of protection against noise that should be provided as part of the development, including the new floor between proposed 1st floor dwellings and Commercial units.
- An assessment of the appropriate level of protection against noise that is likely to be required as part of the development and an outline set of noise control measures.
- Guide noise limits for any external mechanical plant installed as part of the development.

2.0 Baseline Noise Survey

2.1 Measurement Procedures

The instrumentation used for the environmental noise survey consisted of a SvanTek 959 type 1 precision sound level meter. The equipment was calibrated before and after the noise measurements. The sound level meter measured at A-weighted (fast response) noise levels as well as octave bands noise levels for all measurement record.

A fixed noise monitoring position was established outside a 1st floor window and this was used to measure noise levels continuously over a 48hr period from 11:55hrs on Tuesday 19th February until 11:05hrs on Thursday 21st February 2019. The first 24 hour period measures a typical match day

The ambient noise level survey was undertaken between 11:21 to 13:35hrs on the day of 21st February 2019.

The ambient noise measurements were undertaken using the sound level meter microphone at the locations shown in figure 1 below.

The sound level meter was positioned at the following measurement locations on the site:

- Position F1: protruding approx. 1m outside a 1st floor window of existing apartments (197 – 199).
- Position 2: Oakfield Road approx. 5m from roadside.
- Position 3: Oakfield Road approx. 15m from roadside.
- Position 4: Alleyway @ rear of existing dwellings.

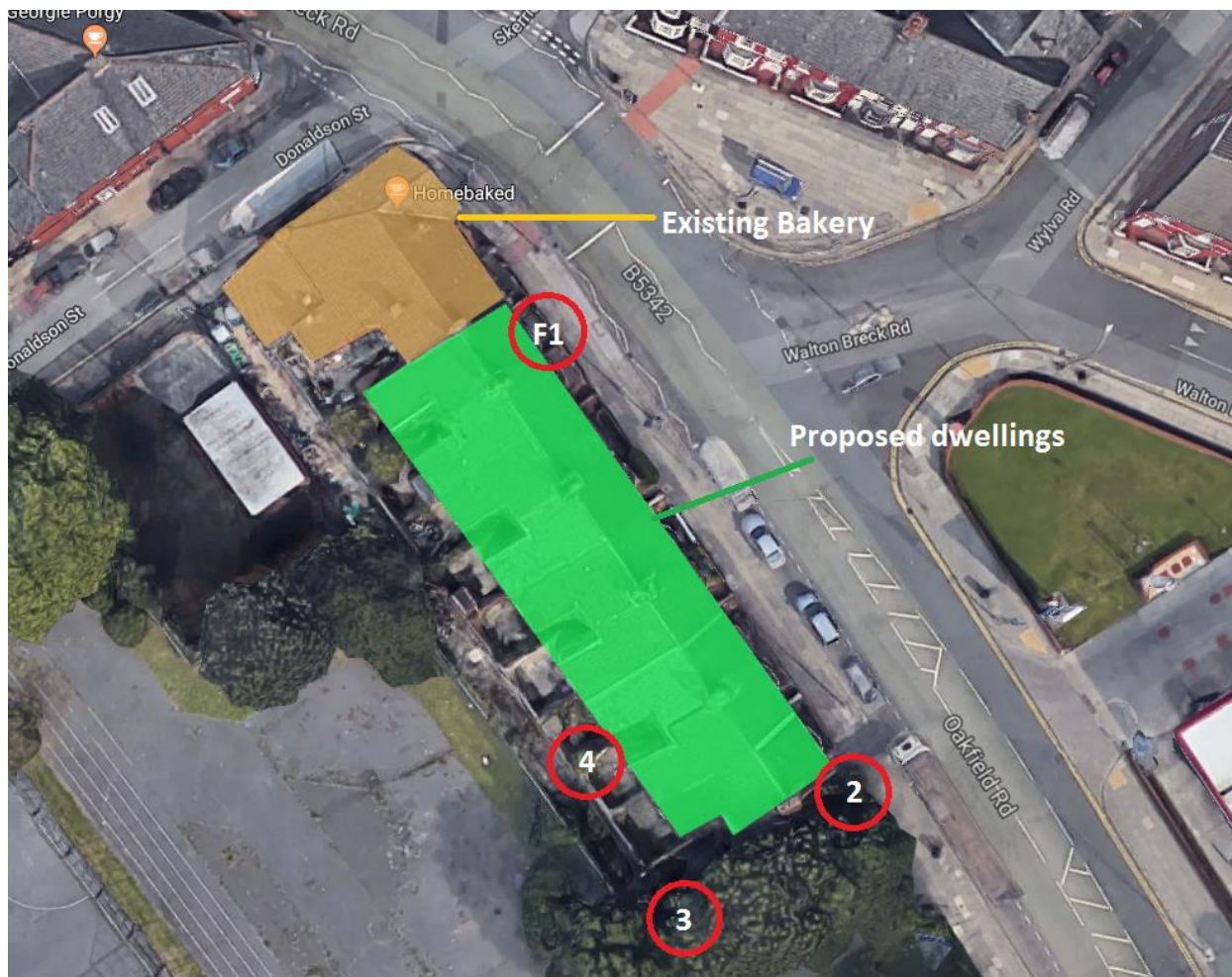


Figure 1: Measurement location circled in red on master plan drawing (building marked in green)



2.2 Measurement Results

A summary of averaged noise measurement data is presented in Table 1; full results are set out in Appendix B. The averaged noise measurement data below presents a typical match day and normal day.

The following table summarises the results of the noise measurements undertaken at the site in terms of averaged day and night time statistical noise levels.

Measurement Location	Time period	L _{Amax}	L _{Aeq}	L _{A1}	L _{A10}	L _{A50}	L _{A90}
F1) 1m outside a 1 st floor window of existing apartments	Match Day (07:00 – 23:00)	85.4	72.8	78.5	73.6	70.1	67.2
F1) 1m outside a 1 st floor window of existing apartments	Normal Day (07:00 – 23:00)	85.2	72.0	79.5	74.5	67.9	60.7
F1) 1m outside a 1 st floor window of existing apartments	Match Evening (19:35 – 22:00)	86.8	74.5	80.8	75.8	73.3	71.8
F1) 1m outside a 1 st floor window of existing apartments	Normal Evening (19:35 – 22:00)	82.6	68.2	77.8	72.0	63.6	54.7
F1) 1m outside a 1 st floor window of existing apartments	Match Night (23:00 – 07:00)	81.9	67.3	75.4	66.9	54.6	46.6
F1) 1m outside a 1 st floor window of existing apartments	Normal Night (23:00 – 07:00)	82.1	64.0	75.1	64.1	49.8	42.3
2) Oakfield Road approx. 5m from roadside	Day (11:21 – 13:35)	76.7	63.4	71.3	67.0	60.5	53.9
3) Oakfield Road approx. 15m from roadside	Day (11:21 – 13:35)	67.6	55.5	62.8	58.4	53.5	49.0
4) Alleyway Rear of existing dwellings.	Day (11:21 – 13:35)	60.2	48.0	55.1	49.0	45.1	42.4

Table 1: Summary of averaged noise measurement results (dBA)

2.3 Description of Noise Climate

The daytime and night time noise climate in the area is dominated by road traffic using Oakfield Road, as well as noise from passers-by. The proposed development is in close proximity to Anfield Football Stadium and as such the noise climate (mainly road traffic and passer-by's) is increased during match days. At the time of daytime measurement, construction noise was apparent to the west of site.

Noise levels in the vicinity of Oakfield Road typically in the range 70 – 72dB L_{Aeq} during the day and 59-66 dB L_{Aeq} during night-time periods. On a regular day (ie no football match), the survey indicates that the background sound level (BSL) is typically around 36-42dB during the night-time.

Figure 2 below shows a chart of existing noise levels at the flat window measurement location F1 for the measured 48-hour period of the survey.

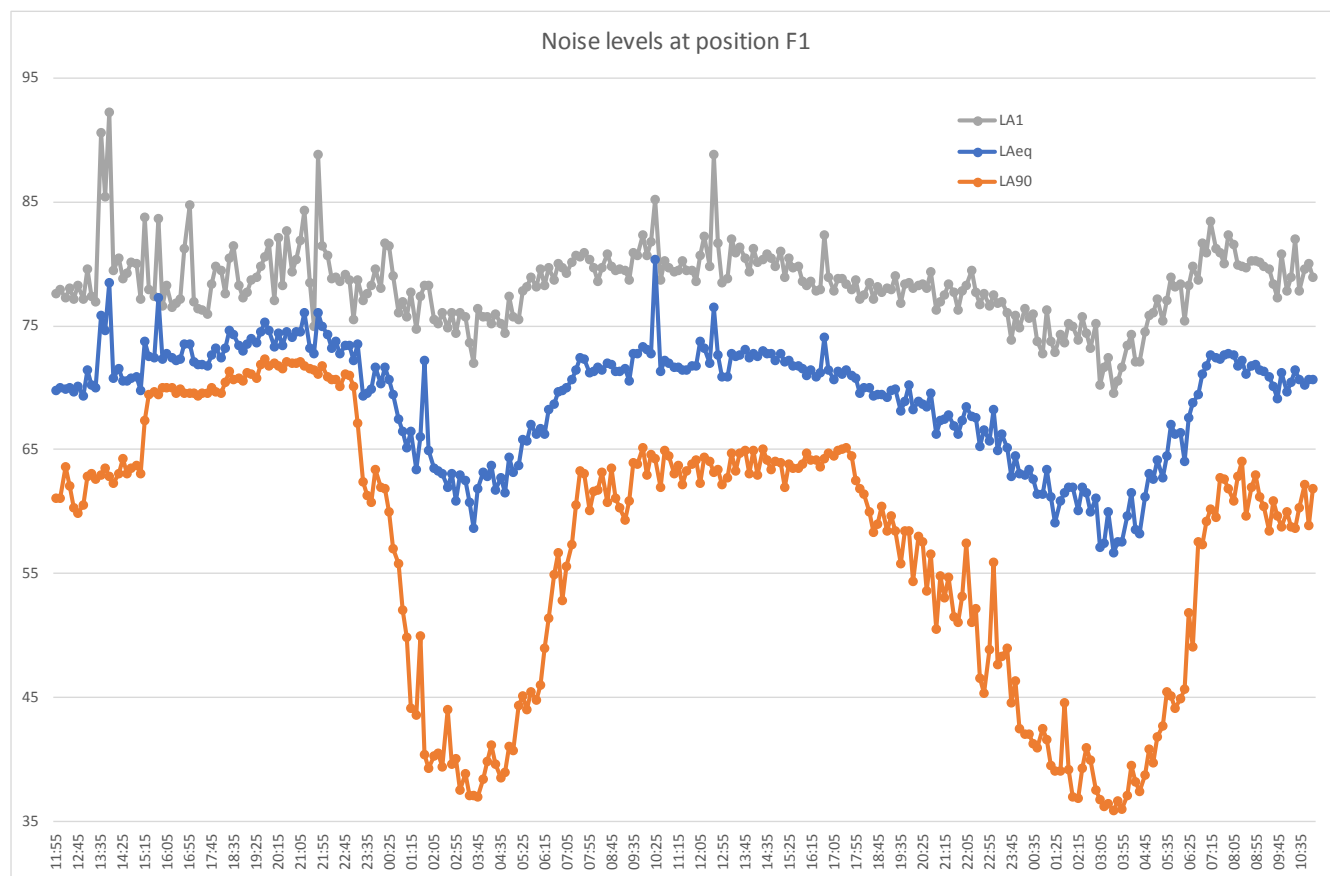


Figure 2: Chart of 48-hour measurement position (Location F1), dBA level over time

3.0 Assessment Criteria

In order to assess the extent of any measures required in order to comply with suitable conditions relating to potential noise sources, Azymuth Acoustics has reviewed various guidance documents and standards, these include:

- ProPG: Professional Practice Guidance on Planning and Noise (New residential development)
- National Planning Policy Framework (NPPF) 2018
- British Standard 8233: 2014
- World Health Organisation Guidelines on Community Noise
- British Standard 4142: 2014

3.1 ProPG: Planning and Noise - May 2017

This Professional Practice Guidance on Planning and Noise (ProPG) has been produced to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England. The National Planning Policy Framework (NPPF) encourages improved standards of design. The CIEH, IOA and the ANC have worked together to produce this guidance which encourages better acoustic design for new residential development and aims to protect people from the harmful effects of noise.

The Professional Practice Guidance on Planning and Noise States ‘The recommended approach is intended to give the developer, noise practitioner, and decision maker an early indication of the likely initial suitability of the site for new residential development from a noise perceptive and the extent of acoustic issues that would be faced’. It is important that acoustic design is reviewed at an early stage of the development process.

3.2 National Planning Policy Framework (NPPF) 2018

The NPPF provides guidance to local authorities taking into account noise in making planning decisions. Paragraph 180 of the National Planning Policy Framework (NPPF) states that planning policies and decisions should aim to:

- Avoid noise giving rise to significant adverse impacts on health and quality of life as a result of new development;
- Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions

The National Planning Policy Framework states that the planning system should ‘prevent both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability’.

3.3 British Standard 8233: 2014

BS 8233 provides a code of practice for the sound insulation of a variety of building types affected by general environmental noise. It provides recommendations for control of noise in and around buildings and suggests appropriate internal ambient noise level criteria / limits for a variety of different situations including residential properties.

The following table summarises the noise limits suggested by BS 8233 applying to residential properties:

Activity	Room	Good Design Range $L_{Aeq,T}$ dB	
		07:00-23:00hrs	23:00-07:00hrs
Resting	Living rooms	35	-
Dining	Dining room / area	40	-
Sleeping (daytime resting)	Bedroom (at night)	35	30

Table 2: Noise Limits for Residential Properties Suggested in BS 8233

3.4 W.H.O. Guidelines on Community Noise

In 1980 the World Health Organisation proposed environmental health criteria for community noise including consideration of noise levels at which sleep disturbance may take place. These guidelines were amended by the World Health Organisation in 1999. The guidance suggests that an internal L_{Aeq} below 30dB is required to preserve the restorative process of sleep. This is equivalent to a free-field level of around 42 to 45dB L_{Aeq} or a façade level of 45 to 48dB L_{Aeq} , assuming open windows.



3.5 British Standard 4142: 2014

The test that is generally applied to assess the potential for noise from industrial and commercial installations to give rise to community response is contained in British Standard BS 4142: 2014. This standard predicts the likelihood of complaint due to noise from a new or modified source.

BS 4142 describes a method for determining the specific source and background noise levels outside residential buildings and for assessing whether the noise is likely to give rise to complaints from the occupants. The specific noise level from the commercial source is rated based on any tonal or intermittent characteristics of the sound.

BS 4142 assessment methodology involves comparing the existing background level with the predicted noise from the new development. This predicted level is adjusted to allow for any tonal or impulsive characteristics and is called the Rating Level. The difference between the two levels can be used to indicate the likelihood of complaints arising, e.g. a predicted level of 10dB greater than the background level indicates a significant adverse impact; an increase of around 5dB indicates an adverse impact and where the rating level does not exceed the background sound level (BSL) this is an indication of the source having a low impact.

In the context of proposed new noise sensitive receptors in the vicinity of industrial sources, the document states that 'where a new noise-sensitive receptor is introduced and there is extant industrial and / or commercial sound, it ought to be recognized that the industrial and / or commercial sound forms a component of the acoustic environment. In such circumstances other guidance and criteria in addition to or alternative to this standard can also inform the appropriateness of both introducing a new noise-sensitive receptor and the extent of required noise mitigation'.

3.6 Recommended Noise Assessment Criteria

Based on the guidance above it is recommended that the following criteria would be reasonable with the aim of minimising the impact of environmental noise on the proposed new residential accommodation:

- Daytime noise levels not to exceed 35dB $L_{Aeq, 16 \text{ hr}}$ in living rooms / bedrooms
- Daytime noise levels not to exceed 40dB $L_{Aeq, 16 \text{ hr}}$ in dining room / kitchen
- Noise levels in bedrooms not to exceed 35dB $L_{Aeq, 16 \text{ hr}}$ for daytime periods
- Night-time noise levels in bedrooms not to exceed 30dB $L_{Aeq, 8 \text{ hr}}$

Table 4, Note 5 of BS 8233:2014 states: 'If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level. If applicable, any room should have adequate ventilation (e.g. trickle ventilators should be open) during assessment.'



4.0 Assessment of Noise Levels

4.1 Assessment of Road Traffic Noise Levels

The results of the Azymuth Acoustics UK survey indicates that the daytime façade noise levels along the Oakfield Road (at 3 – 5m from the kerb-side) are typically 70-73 dB $L_{Aeq, 1 \text{ hour}}$ during the daytime and typically 60-64 dB $L_{Aeq, 1 \text{ hour}}$ during the night-time. Noise contribution from Anfield Football Stadium affected the overall measured levels and this is discussed in more detail below. In accordance with the ProPG pre-planning guidance, this would be deemed to represent a medium to high noise risk during the daytime and a medium to high noise risk during the night-time.

The internal noise limit criteria detailed in Section 3.6 relate to 16 hour daytime and 8 hour night time average levels. As such, the measured average daytime and night time noise levels are used to assess the required level of noise reduction from outside to inside new dwellings.

The daytime noise levels to the sides & rear of the development have been found to be typically in the range 48-54 dB $L_{Aeq, 16 \text{ hour}}$ with these noise levels including a modest contribution of road traffic noise from Oakfield Road. This would normally imply that that rear of the site can be deemed to represent a low noise risk within the ProPG pre-planning guidance.

On the basis of the measured noise levels it is estimated that an overall noise reduction of 33 - 35 dB would normally be required through the façade in order to achieve satisfactory conditions inside rooms facing directly on to the Oakfield Road perimeter of the site. Reduced levels of noise reduction are appropriate for the other façade elevations. These levels of noise reductions are presented in greater detail in Section 5 of the report which identifies the recommended mitigation measures for this scheme.

4.2 Assessment of Anfield Football Stadium Noise Levels

The proposed development is in the vicinity of Anfield Football Stadium (Approx. 85m south east of the nearest dwelling) and as such road traffic and pedestrian noise levels along Oakfield Road are likely to increase. Noise contribution from crowd chanting / speaker announcements from the stadium is apparent.

It is understood that match days generally occur once a week up until summer time where matches are less frequent. In addition, matches generally begin during mid-afternoon periods, as well as late evening periods up with crowds dispersing by approx. 00:00hrs.

Based on the measurement data from the fixed monitoring position it can be seen that noise levels are likely to increase by approx. 2dB $L_{Aeq, 16 \text{ hrs}}$ for day and approx. 3dB $L_{Aeq, 8 \text{ hrs}}$ for night-time periods on match days (depending on times scales). The background sound level is likely to increase by approx. by 7dB $L_{A90, 16 \text{ hrs}}$ during the day and 5dB $L_{A90, 8 \text{ hrs}}$ during the night. The results from the continuous noise measurements at the Oakfield Road boundary indicate that noise levels from football match activity decrease from approx. 00:25hrs.

The (façade) noise levels during the evening period of the match of 19/02/2019 were typically 73-76 dB $L_{Aeq, 10 \text{ min}}$ between 19:35 to 22:00hrs. However, the following day the noise levels for the equivalent period were recorded as 66 to 70 dB $L_{Aeq, 10 \text{ min}}$. Thus noise levels from crowd / matchday activity is up to 5-6 dB higher than on a normal evening and maximum levels of 86-90 dB L_{Amax} were recorded during the matchday evening period.

4.3 Assessment of Bakery Extension and Proposed Micro-brewery Noise Levels

At the present time the nature of the commercial premises has not been fully specified, however, the following bullet points set out the proposals as they stand:

- i) The existing but extended Homebaked bakery café and bistro with revised opening hours of 08:00 to 22:00hrs;
- ii) Small commercial premises likely to be an office or small craft based business or shop (nominally 09:00 to 17:30hrs);
- iii) A micro-brewery at the other end of the terrace which will be mainly for the brewing and sale of beer and likely be open from 09:00 to 22:00hrs.

For the purpose of this noise assessment Azymuth Acoustics UK has considered the following general aspects of the proposed commercial premises:

- Fixed plant associated with the residential and commercial elements of the scheme;
- Noise break-out from the commercial elements of the scheme; worst case noise levels inside the Homebaked café and the micro-brewery on the ground floor sections of the development are assumed to be in the range 80-85 dBA (i.e. typical for cafés and restaurants)
- The glazing for the windows of the commercial units is assumed to have a minimum sound insulation value R_w 34 dB. The resulting noise level @1m outside the commercial units will be 43-46 dBA based on the 80-85dBA internal noise level; NB R_w 36 dB is recommended for the glazing in the mitigation measures.

5.0 Recommendations for Noise Mitigation

This section sets out the recommended minimum noise mitigation measures required in order to satisfy the requirements of the noise assessment criteria and ensure satisfactory noise conditions inside and (generally where practical) outside the proposed residential properties.

5.1 Glazing Specifications (dwellings)

The appropriate specifications for the glazing to the new dwellings based on the current proposed layout are summarised in Table 6 and Figure 3 below.

Location (Bedrooms, Living Rooms, Dining Rooms)	Glazing Specifications	Appropriate Glazing Types
All Elevations	Airborne sound insulation min. R_w 38dB and $R_{w+C_{tr}}$ 34dB	Acoustically rated secure by design laminated triple glazing

Table 6: Recommended glazing specifications for new dwellings, Homebaked site

5.2 Ventilation Specifications (dwellings)

The recommended ventilation strategy based on the current proposed layout are summarised in Table 4 below.

Location (Bedrooms, Living Rooms, Dining Rooms)	Ventilation Specifications	Window slot vent trickle ventilation (where applicable)
Oakfield Road elevation: generally, elevations and side façades of dwellings facing onto Oakfield Road	System 3 fan assisted enhanced background ventilation Opening windows generally acceptable during hottest days of the year (daytime)	None - whole house MEV proposed (MVHR if affordable)

Table 4: Recommended ventilation strategy for Homebaked site

5.3 Separating Floors and Ceilings

At the present time the exact separating floor construction is not known; Azymuth Acoustics UK recommends that the minimum sound insulation for the floors between the micro-brewery and the residential dwellings should be D_{nw} 60dB or higher. This acoustic specification should be deemed to be additional to the requirements of Approved Document E of the Building Regulations. A similar target would be recommended for the separating floor between the new / refurbished / extended elements of the Homebaked bakery / cafe.

[/This (D_{nw} 60dB / $D_{ntw} + C_{tr}$ 50 dB or higher target value) can be achieved by a suitable insulated timber floor construction comprising a minimum surface mass of 95kg/m² for the separating floor / ceiling as a whole and including a minimum 100mm absorbent mineral wool layer with minimum density of 10kg/m³.]



Figure 3: areas of floor / ceiling where enhanced sound insulation is recommended



All other separating floors and walls should comply with Approved Document E of the Building Regulations.

5.4 Other elements of the Building Envelope

Other elements of the building envelope should have the following minimum sound insulation performance:

- External Walls: minimum sound insulation R_w 52dB. This minimum is likely to be significantly exceeded by a normal brickwork façade. Where alternative external wall types are proposed on habitable areas it will be appropriate to check that they comply with the R_w 52dB target.
- Roof: minimum sound insulation R_w 45dB. This minimum will be exceeded with a traditional slate tile roof with mineral wool or other fibre based loft insulation above plasterboard ceiling (where rigid foam insulation is specified then this can be checked by a suitably qualified acoustic consultant).

5.5 Noise Limits for Fixed Plant at Commercial Premises

It is proposed most external plant equipment will be situated to the rear of the dwellings / commercial units at roof level, with exception of toilets vents which are likely exit into the bakery yard. It is understood that the plant associated with the premises will consist of the following items:

- Toilet Vents
- Kitchen Extraction (new or altered)

At present specific items of plant have not been selected for these items hence the following assessment is based on generic performance criteria for this type of plant and relevant noise criteria based on BS4142 and the results of the noise measurements.

Cumulative daytime noise levels (kitchen operating hours) from fixed plant not greater than 52dBA @ 1m distance from atmosphere connections; this equates to ≤ 45 dBA externally at the nearest residential properties (ie the residential elements of the scheme itself).

Compliance with this noise limit will ensure that the combined noise level at the nearest noise sensitive residential receptors will be at or below the existing background sound level (this equates to typically 42dBA externally at the nearest residential properties and < 32 dBA inside dwellings.).

All ventilation ducted connecting with the proposed premises must be suitably attenuated.



5.0 Conclusions

Azymuth Acoustics UK has undertaken an environmental noise assessment of the proposed residential / commercial development at Oakfield Road, Anfield, Liverpool. Noise levels affecting the site are dominated by road traffic using Oakfield Road and noise from crowd chanting / speaker announcements from Anfield Stadium.

The project proposes the conversion of 9 terrace houses into a mixed residential / commercial development (including a restaurant & micro-brewery). A schedule of acoustic glazing and ventilation has been recommended in order to protect future residents from environmental noise.

5.1 Summary

A summary of the main points is detailed below:

- Bedrooms and living rooms on façades in close proximity to Oakfield Road should be fitted with min. Rw38dBA glazing.
- All facades should incorporate system 3 fan assisted background ventilation.
- Façades away from roads may be ventilated by means of opening windows, for both day and night time periods.
- The minimum sound insulation for the floors between the micro-brewery and the residential dwellings should be D_{nw} 60dB or higher. This level of sound insulation can be achieved by a suitable insulated timber floor construction comprising a minimum surface mass of 95kg/m² for the separating floor / ceiling as a whole and including a minimum 100mm absorbent mineral wool layer with minimum density of 10kg/m³.
- Where necessary the sound levels on any sound system in leisure premises should be controlled by a tamper proof sound level limiter installed on the proposed sound system, to be set to comply with a noise limit of 85 dB L_{Aeq, 1min}.
- Cumulative daytime noise levels (kitchen operating hours) from fixed plant not greater than 52dBA @ 1m distance from atmosphere connections



Appendix A – Glossary of Terms

Decibel (dB)

this is the unit used to measure sound. The human ear has an approximately logarithmic response to acoustic pressure over a very large dynamic range (typically 20 micro Pascal to 100 Pascal).

dB (A)

This is a measure of the overall noise level of sound across the audible spectrum with a frequency weighting (i.e. A-weighting) to compensate for the sensitivity of the human ear to sound of different frequencies. The A-weighting curve is implemented in sound level meters using an electronic filter that approximately corresponds to the frequency response of the ear.

Octave Band Noise Level

The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz. The ear is also generally more sensitive to medium and high frequencies than to low frequencies. In order to define the frequency content of a noise, the spectrum can be divided into frequency bands. The most commonly used frequency bands are octave bands, in which the mid-frequency of each band is twice that of the band below it.

L_{Aeq}

this is the equivalent steady sound level in dB (A) containing the same acoustic energy as the actual fluctuating sound level over a given time period.

Reverberation Time (RT or sometimes T_{30} or T_{60})

This is the time taken for the reverberant sound energy in an enclosure to decay one millionth of its equilibrium value, i.e. by 60 dB, after the source has been switched off, is known as the reverberation time. The reverberation time is frequency dependent and it is customary to measure its value in octave or one-third octave bands. Reverberation occurs when sound waves are repeatedly reflected from each surface of the room.

Sound Reduction Index (SRI)

Difference measured between the amount of energy flowing towards the wall in the source room and the total amount of energy flowing towards the wall in the source room and the total amount of energy entering the receiving room (usual range 100 - 3150 Hz for one third octave band values). The SRI varies with frequency and is measured in a laboratory in either octave or one-third octave bands.

$$SRI = L_1 - L_2 + 10 \log (S/A)$$

Where: L_1 = Noise level in the source room

L_2 = Noise levels in the receiving room

S = Surface area of test specimen

A = Equivalent acoustic absorption area in the receiving room

Weighted Sound Reduction Index (R_w)

this is a weighted single figure descriptor of the sound insulation performance of a partition measured under laboratory conditions. The procedure used to quantify the R_w is to compare the sound reduction index (SRI) in each of the one-third octave bands from 100Hz to 3150Hz against a set of standard reference curves.

Appendix B – Full tabulation of results

Start	Position	Time	L _{Amax}	L _{Aeq}	L _{A1}	L _{A10}	L _{A50}	L _{A90}
19 th February 2019 Day								
11:55	F1	10:00	85.7	69.8	77.6	73.3	67.5	61.1
12:05	F1	10:00	80.5	70	77.9	73.6	67.9	61.1
12:15	F1	10:00	81.2	69.9	77.3	72.9	68.4	63.6
12:25	F1	10:00	85.1	70	78	73.4	67.7	62.1
12:35	F1	10:00	83	69.7	77.2	73.3	67.8	60.3
12:45	F1	10:00	87.7	70.1	78.2	73.4	67.3	59.9
12:55	F1	10:00	82	69.3	77.2	73	66.8	60.5
13:05	F1	10:00	89.7	71.4	79.6	74.7	68.7	62.8
13:15	F1	10:00	83.6	70.2	77.4	73.5	68.4	63.1
13:25	F1	10:00	79.8	70	76.9	73.8	67.8	62.6
13:35	F1	10:00	96.3	75.8	90.6	73.8	67.7	62.9
13:45	F1	10:00	100.3	74.6	85.4	73.9	68.7	63.5
13:55	F1	10:00	98.5	78.5	92.2	75.5	68.4	62.8
14:05	F1	10:00	85.7	70.8	79.5	74.3	68	62.3
14:15	F1	10:00	89.9	71.5	80.5	74	68.2	63
14:25	F1	10:00	86.8	70.5	78.8	73.5	68.2	64.3
14:35	F1	10:00	84.4	70.5	79.2	73.8	68	63.1
14:45	F1	10:00	90.7	70.8	80.1	73	67.9	63.5
14:55	F1	10:00	88.4	70.9	80	73.6	68.5	63.7
15:05	F1	10:00	84.4	69.8	77.2	72.9	67.8	63
15:15	F1	10:00	93	73.7	83.8	74.9	70.6	67.3
15:25	F1	10:00	83	72.5	77.9	74.8	71.5	69.4
15:35	F1	10:00	80.3	72.4	77.4	74.7	71.7	69.7
15:45	F1	10:00	103.2	77.3	83.7	75.2	71.7	69.4
15:55	F1	10:00	81.4	72.3	76.6	74.4	71.7	70
16:05	F1	10:00	86.4	72.7	78.2	74.6	71.8	70
16:15	F1	10:00	80	72.4	76.5	74.5	71.8	70
16:25	F1	10:00	83	72.2	76.8	74.5	71.5	69.5
16:35	F1	10:00	85.5	72.3	77.2	74.3	71.6	69.9
16:45	F1	10:00	93.6	73.5	81.2	74.8	71.7	69.6
16:55	F1	10:00	94.3	73.5	84.7	74	71.3	69.5
17:05	F1	10:00	82	72.1	76.9	74.2	71.5	69.5
17:15	F1	10:00	84.5	71.9	76.4	73.9	71.3	69.3
17:25	F1	10:00	86.5	71.9	76.3	73.6	71.2	69.5
17:35	F1	10:00	80.3	71.8	75.9	73.8	71.3	69.6
17:45	F1	10:00	88.1	72.6	78.4	74.3	71.6	70
17:55	F1	10:00	92.2	73.2	79.8	74.9	71.5	69.7
18:05	F1	10:00	87.9	72.4	79.5	74.1	71.3	69.6
18:15	F1	10:00	84.8	73.2	77.6	75	72.7	70.4
18:25	F1	10:00	84.5	74.6	80.5	77.1	73.6	71.3



Start	Position	Time	L _{Amax}	L _{Aeq}	L _{A1}	L _{A10}	L _{A50}	L _{A90}
18:35	F1	10:00	85.7	74.3	81.5	76.5	73.2	70.6
18:45	F1	10:00	83.3	73.4	78.3	75.1	73	70.8
18:55	F1	10:00	81.5	73	77.3	74.7	72.6	70.5
19:05	F1	10:00	86.8	73.5	77.7	75.2	73.2	71.2
19:15	F1	10:00	87.8	74	78.7	75.8	73.4	71.1
19:25	F1	10:00	83.5	73.6	78.9	75.6	73	70.8
19:35	F1	10:00	85.9	74.5	79.8	76.3	73.9	71.9
19:45	F1	10:00	85.8	75.3	80.6	77.3	74.6	72.3
19:55	F1	10:00	88.8	74.6	81.7	76.2	73.6	71.7
20:05	F1	10:00	82.3	73.3	77	74.6	73	72
20:15	F1	10:00	90.4	74.4	82.1	75.2	73	71.7
20:25	F1	10:00	82	73.4	78.3	75.2	72.8	71.5
20:35	F1	10:00	88.3	74.5	82.7	75.8	73.4	72.1
20:45	F1	10:00	80.6	74.1	79.3	76.4	73.3	72
20:55	F1	10:00	90.4	74.5	80.4	75.6	73.3	72
21:05	F1	10:00	84.8	74.5	81.9	76.4	73.5	72.1
21:15	F1	10:00	90.3	76	84.3	78.8	73.5	71.8
21:25	F1	10:00	88.7	73.2	78.5	74.2	72.6	71.5
21:35	F1	10:00	80.6	72.7	75	73.7	72.6	71.4
21:45	F1	10:00	97.2	76.1	88.8	73.9	72.8	71.1
21:55	F1	10:00	86.6	75	81.5	77.8	73.7	71.7
22:05	F1	10:00	85	74.3	80.7	76.6	73.2	70.9
22:15	F1	10:00	84.4	73.2	78.8	75.4	72.4	70.6
22:25	F1	10:00	84.4	73.7	78.9	76.1	72.8	70.6
22:35	F1	10:00	89.3	72.7	78.6	74.4	71.8	70.1
22:45	F1	10:00	82.2	73.4	79.1	75	72.7	71.1
22:55	F1	10:00	90.7	73.4	78.7	74.9	72.8	71
19 th - 20 th February 2019 Night								
23:05	F1	83.8	72.2	75.5	73.7	72.1	70.1	83.8
23:15	F1	94.6	73.5	78.7	75.2	72.7	67.1	94.6
23:25	F1	80.6	69.3	77	72.9	67.1	62.4	80.6
23:35	F1	83.5	69.5	77.6	73.1	67.1	61.3	83.5
23:45	F1	82.9	69.9	78.3	73.1	68	60.7	82.9
23:55	F1	88.3	71.6	79.6	74.7	69	63.4	88.3
00:05	F1	83	70.3	78	73.7	68.2	61.9	83
00:15	F1	90	71.6	81.7	74.3	68.1	61.8	90
00:25	F1	88.3	70.7	81.4	73.8	67	60	88.3
00:35	F1	84	69.4	79	73.5	65.2	57	84
00:45	F1	81	67.5	76.1	71.6	64	55.8	81
00:55	F1	79.9	66.5	76.9	70.6	61	52	79.9
01:05	F1	82	65.2	75.7	69.7	58.6	49.8	82
01:15	F1	84.8	66.5	77.7	70.6	56.3	44.1	84.8
01:25	F1	79.8	63.4	74.7	67.6	55.1	43.6	79.8



Start	Position	Time	L _{Amax}	L _{Aeq}	L _{A1}	L _{A10}	L _{A50}	L _{A90}
01:35	F1	82.5	66	77.4	69.5	58.8	49.9	82.5
01:45	F1	98.6	72.2	78.3	65.4	48.1	40.4	98.6
01:55	F1	82.9	64.9	78.2	66.4	50.1	39.3	82.9
02:05	F1	82.3	63.5	75.5	66.9	51.5	40.3	82.3
02:15	F1	85	63.3	75.2	66.1	51	40.5	85
02:25	F1	84.6	63.1	76	63.1	47.3	39.4	84.6
02:35	F1	81.1	62	74.8	64.4	49.6	44	81.1
02:45	F1	84.3	63.1	76	64.9	51.1	39.6	84.3
02:55	F1	78.9	60.9	74.4	61.7	48.8	40	78.9
03:05	F1	80.3	62.9	76.1	65.5	45.5	37.5	80.3
03:15	F1	81.3	62.5	75.7	63.7	47.7	38.8	81.3
03:25	F1	84.7	60.7	73.6	58.2	39.3	37.1	84.7
03:35	F1	80.7	58.7	72	59.1	42.5	37.1	80.7
03:45	F1	80.4	61.8	76.4	60.8	42	36.9	80.4
03:55	F1	84.3	63.2	75.7	64.7	48	38.4	84.3
04:05	F1	82.1	62.8	75.7	65.2	46.6	39.8	82.1
04:15	F1	82.2	63.7	75.2	67	53.7	41.1	82.2
04:25	F1	80.8	61.7	75.9	62.2	45.3	39.6	80.8
04:35	F1	86.4	62.7	75.2	62.8	42.5	38.5	86.4
04:45	F1	80.9	61.5	74.4	63.6	47.4	38.9	80.9
04:55	F1	84.3	64.4	77.4	65.9	46	41	84.3
05:05	F1	81	63.2	75.7	66.2	49.3	40.7	81
05:15	F1	82.9	63.7	75.5	66	56	44.3	82.9
05:25	F1	83.2	65.8	77.8	69.5	55.1	45.1	83.2
05:35	F1	82.7	65.7	78.1	68.6	56.9	44	82.7
05:45	F1	84.3	67	78.9	69.8	55	45.4	84.3
05:55	F1	82.7	66.2	78.1	69.7	55.5	44.8	82.7
06:05	F1	85.4	66.7	79.6	69.5	56.3	46	85.4
06:15	F1	84	66.3	78.2	69.7	57.3	48.9	84
06:25	F1	84.9	68.2	79.7	71.8	61.2	51.4	84.9
06:35	F1	83.1	68.7	78.7	72.8	62.7	54.9	83.1
06:45	F1	83.2	69.7	80	73.6	64.6	56.7	83.2
06:55	F1	82.6	69.8	79.7	74	64.9	52.8	82.6
20 th February 2019 Day								
07:05	F1	87	70	79.2	74.1	65.1	87	70
07:15	F1	85	70.6	80.1	74.7	65.7	85	70.6
07:25	F1	86.7	71.4	80.7	75	67.7	86.7	71.4
07:35	F1	84.4	72.4	80.6	76.2	69.5	84.4	72.4
07:45	F1	87.7	72.3	80.9	75.8	69.5	87.7	72.3
07:55	F1	86	71.2	80.3	74.9	68.1	86	71.2
08:05	F1	82.6	71.3	79.7	75.2	68.5	82.6	71.3
08:15	F1	82.9	71.6	78.6	75.4	69.4	82.9	71.6
08:25	F1	82.9	71.4	79.7	75.1	68.9	82.9	71.4



Start	Position	Time	L _{Amax}	L _{Aeq}	L _{A1}	L _{A10}	L _{A50}	L _{A90}
08:35	F1	85.4	72	80.8	75.7	69.2	85.4	72
08:45	F1	84.9	71.9	79.8	75.3	69.8	84.9	71.9
08:55	F1	84.7	71.3	79.5	75.1	68.5	84.7	71.3
09:05	F1	85.8	71.3	79.6	75	68.5	85.8	71.3
09:15	F1	82.3	71.5	79.5	75.4	69.2	82.3	71.5
09:25	F1	82.7	70.5	78.7	74.4	67.7	82.7	70.5
09:35	F1	84.1	72.7	80.9	76.2	70.8	84.1	72.7
09:45	F1	85.5	72.8	80.7	76.4	70.5	85.5	72.8
09:55	F1	85.5	73.3	82.3	76.4	71	85.5	73.3
10:05	F1	83.8	73.1	80.7	76.6	71.5	83.8	73.1
10:15	F1	87.7	72.8	81.8	75.9	70	87.7	72.8
10:25	F1	109.8	80.4	85.2	76.5	70.7	109.8	80.4
10:35	F1	82.3	71.3	78.7	75	69.2	82.3	71.3
10:45	F1	83.5	72.2	80.2	75.6	70	83.5	72.2
10:55	F1	84.7	72	79.7	75.4	69.9	84.7	72
11:05	F1	86	71.6	79.3	75.2	69.6	86	71.6
11:15	F1	84.3	71.6	79.5	75	69.7	84.3	71.6
11:25	F1	84.3	71.4	80.2	74.8	68.9	84.3	71.4
11:35	F1	83.8	71.4	79.5	74.9	69.3	83.8	71.4
11:45	F1	82.2	71.8	79.5	75.5	69.6	82.2	71.8
11:55	F1	83.6	71.7	78.6	75	70.1	83.6	71.7
12:05	F1	95	73.7	80.7	75.9	69.9	95	73.7
12:15	F1	87.3	73.2	82.2	76.1	70.6	87.3	73.2
12:25	F1	83.9	72	79.8	75.6	69.8	83.9	72
12:35	F1	98.9	76.5	88.8	76.7	69.7	98.9	76.5
12:45	F1	92.8	72.6	81.7	75.3	69.6	92.8	72.6
12:55	F1	82	70.9	78.5	74.6	68.7	82	70.9
13:05	F1	84.4	70.9	78.8	74.6	68.4	84.4	70.9
13:15	F1	84.6	72.8	82	76.3	70.3	84.6	72.8
13:25	F1	86.1	72.5	80.9	75.9	70.2	86.1	72.5
13:35	F1	84.8	72.6	81.3	76.1	70	84.8	72.6
13:45	F1	83.4	73.1	80.5	76.8	71.2	83.4	73.1
13:55	F1	83.3	72.4	79.4	75.7	71.1	83.3	72.4
14:05	F1	84.5	72.8	81.2	76.2	70.7	84.5	72.8
14:15	F1	83.1	72.5	80.1	76.1	70.6	83.1	72.5
14:25	F1	83.2	73	80.4	76.6	71.2	83.2	73
14:35	F1	87.6	72.8	80.8	76.3	70.3	87.6	72.8
14:45	F1	83.4	72.8	80.5	76.4	70.8	83.4	72.8
14:55	F1	82.8	72.2	79.8	75.8	70.1	82.8	72.2
15:05	F1	87.9	72.7	81	75.8	70.5	87.9	72.7
15:15	F1	98.3	72.1	78.9	74.6	68.6	98.3	72.1
15:25	F1	91.8	72.2	80.5	75.1	69.3	91.8	72.2
15:35	F1	84.9	71.8	79.7	75.2	69.5	84.9	71.8



Start	Position	Time	L _{Amax}	L _{Aeq}	L _{A1}	L _{A10}	L _{A50}	L _{A90}
15:45	F1	82	71.8	79.8	75.2	69.8	82	71.8
15:55	F1	86	71.5	78.6	74.9	69.5	86	71.5
16:05	F1	82.5	71	78.2	74.1	69.4	82.5	71
16:15	F1	82.9	71.4	78.6	74.4	69.9	82.9	71.4
16:25	F1	80	70.9	77.8	74.3	69.4	80	70.9
16:35	F1	80	71.2	77.9	74.6	69.6	80	71.2
16:45	F1	97	74.1	82.3	75.1	69.2	97	74.1
16:55	F1	83.1	71.4	78.9	74.7	69.6	83.1	71.4
17:05	F1	81.5	70.6	77.8	73.7	69.1	81.5	70.6
17:15	F1	81.2	71.3	78.8	74.3	69.6	81.2	71.3
17:25	F1	83.6	71.1	78.8	74.3	69.3	83.6	71.1
17:35	F1	81.7	71.4	78.4	74.6	69.7	81.7	71.4
17:45	F1	83.1	71	77.9	74.2	69.4	83.1	71
17:55	F1	86.7	70.8	78.7	74.2	68.6	86.7	70.8
18:05	F1	82.4	69.6	77.2	73.2	67.5	82.4	69.6
18:15	F1	82.7	70	77.5	73.6	67.8	82.7	70
18:25	F1	82.7	70	78.5	73.7	67.6	82.7	70
18:35	F1	80.6	69.3	77.1	72.9	67.1	80.6	69.3
18:45	F1	85.4	69.4	78.1	73	66.8	85.4	69.4
18:55	F1	93.4	69.4	77.7	72.7	66.1	93.4	69.4
19:05	F1	81	69.2	78	73.3	65.6	81	69.2
19:15	F1	80.3	69.8	77.9	73.8	67.1	80.3	69.8
19:25	F1	82.4	69.9	79	73.9	66.1	82.4	69.9
19:35	F1	82	68.1	76.8	72.2	64.4	82	68.1
19:45	F1	84.6	68.9	78.4	72.6	65.6	84.6	68.9
19:55	F1	83.3	70.2	78.5	74.4	66.9	83.3	70.2
20:05	F1	81.6	68.2	78	72.4	63.9	81.6	68.2
20:15	F1	81.6	68.9	78.2	72.8	65.5	81.6	68.9
20:25	F1	80.9	68.7	78.4	72.5	65	80.9	68.7
20:35	F1	82.8	68.5	78	73	63.7	82.8	68.5
20:45	F1	82.8	69.5	79.3	73.3	65.3	82.8	69.5
20:55	F1	84.8	66.3	76.3	70.1	61.2	84.8	66.3
21:05	F1	82	67.3	76.9	71.6	62.4	82	67.3
21:15	F1	83.2	67.5	77.5	71.6	63.6	83.2	67.5
21:25	F1	81.9	67.8	78.4	71.8	62	81.9	67.8
21:35	F1	81.7	66.9	77.7	70.8	60.8	81.7	66.9
21:45	F1	80.2	66.3	76.3	70.6	61.1	80.2	66.3
21:55	F1	85.5	67.3	77.8	71	62	85.5	67.3
22:05	F1	80.7	68.5	78.2	72.6	64.3	80.7	68.5
22:15	F1	84.8	67.7	79.5	71.1	61	84.8	67.7
22:25	F1	81.9	67.6	77.7	72.2	60.7	81.9	67.6
22:35	F1	80.5	65.3	76.7	68.9	59	80.5	65.3
22:45	F1	84.9	66.6	77.6	70.7	58.4	84.9	66.6



Start	Position	Time	L _{Amax}	L _{Aeq}	L _{A1}	L _{A10}	L _{A50}	L _{A90}
22:55	F1	80.7	65.7	76.6	69.7	58.5	80.7	65.7
20 th – 21 st February 2019 Night								
23:05	F1	82.5	68.2	77.5	72.0	63.9	82.5	68.2
23:15	F1	82	64.9	76.8	67.9	56.5	82	64.9
23:25	F1	84.6	66.2	76.9	70.2	58.9	84.6	66.2
23:35	F1	82.3	65.1	76.1	69.1	58	82.3	65.1
23:45	F1	81.7	62.8	73.8	66.4	53.9	81.7	62.8
23:55	F1	81.1	64.5	75.8	68.5	55.8	81.1	64.5
00:05	F1	85.2	63	74.8	65.3	51.9	85.2	63
00:15	F1	80.5	62.9	76.4	64.3	50.8	80.5	62.9
00:25	F1	83.5	63.4	75.6	65.6	53.6	83.5	63.4
00:35	F1	80.4	62.6	75.9	64.5	48.3	80.4	62.6
00:45	F1	80.6	61.4	73.7	64.3	51.4	80.6	61.4
00:55	F1	82.2	61.4	72.8	63.8	51.7	82.2	61.4
01:05	F1	82.6	63.4	76.3	64.7	50.3	82.6	63.4
01:15	F1	82.4	61.2	73.7	63.8	47.2	82.4	61.2
01:25	F1	79.6	59.1	72.9	59.8	43.4	79.6	59.1
01:35	F1	81.1	60.9	74.3	61.4	46.2	81.1	60.9
01:45	F1	81.6	61.5	73.6	64.3	53.4	81.6	61.5
01:55	F1	81.8	62	75.2	62.8	48.2	81.8	62
02:05	F1	83.6	61.9	75	62.3	43.2	83.6	61.9
02:15	F1	80.6	60.1	73.9	60.1	42.3	80.6	60.1
02:25	F1	83.6	61.9	75.7	61.6	44	83.6	61.9
02:35	F1	79	61.5	74.4	64	48.5	79	61.5
02:45	F1	79.8	60	73.2	61.3	45.2	79.8	60
02:55	F1	81.8	61.1	75.2	59	40.8	81.8	61.1
03:05	F1	78.2	57.1	70.2	54.9	39	78.2	57.1
03:15	F1	79.3	57.4	71.6	51.8	38.2	79.3	57.4
03:25	F1	83.7	60	72.4	57.5	38.8	83.7	60
03:35	F1	79.6	56.7	69.6	55.7	38.2	79.6	56.7
03:45	F1	77.9	57.6	70.5	59.5	40.3	77.9	57.6
03:55	F1	79.3	57.5	71.6	57.3	40.1	79.3	57.5
04:05	F1	82.6	59.6	73.4	57.3	42.5	82.6	59.6
04:15	F1	82.9	61.5	74.3	62.8	48	82.9	61.5
04:25	F1	82.2	58.5	72.1	57.5	41.3	82.2	58.5
04:35	F1	77.9	58.2	72.1	59.3	43.1	77.9	58.2
04:45	F1	83.1	61.2	74.5	61.8	45.1	83.1	61.2
04:55	F1	83.9	63.1	75.8	65.7	47.1	83.9	63.1
05:05	F1	84.5	62.6	76	63.4	44.6	84.5	62.6
05:15	F1	82.6	64.2	77.2	65.9	49.4	82.6	64.2
05:25	F1	82.1	62.7	75.4	64.5	51.4	82.1	62.7
05:35	F1	81.7	64.5	77	67.5	56.7	81.7	64.5
05:45	F1	86.9	67	78.9	70	58.1	86.9	67



Start	Position	Time	L _{Amax}	L _{Aeq}	L _{A1}	L _{A10}	L _{A50}	L _{A90}
05:55	F1	84.5	66.2	78.1	69.4	55	84.5	66.2
06:05	F1	83.4	66.4	78.4	70.2	55.9	83.4	66.4
06:15	F1	81.2	64	75.4	67.5	55.2	81.2	64
06:25	F1	81.6	67.6	78.3	71.7	61.7	81.6	67.6
06:35	F1	85.7	68.8	79.8	72.5	61.7	85.7	68.8
06:45	F1	82.3	69.4	78.7	73.4	65.5	82.3	69.4
06:55	F1	87.4	71.1	81.7	74.5	65.5	87.4	71.1
21 st February 2019 Day								
07:05	F1	85.4	71.8	80.9	76.1	67.5	85.4	71.8
07:15	F1	88.5	72.6	83.4	75.6	67.7	88.5	72.6
07:25	F1	88.4	72.4	81.2	76.4	67.9	88.4	72.4
07:35	F1	84	72.3	80.9	76.1	69.5	84	72.3
07:45	F1	82.5	72.6	80	76.4	70.4	82.5	72.6
07:55	F1	90.4	72.8	82.3	76.1	69.5	90.4	72.8
08:05	F1	91.4	72.6	81.6	75.8	69.1	91.4	72.6
08:15	F1	85.7	71.7	79.9	75.3	68.6	85.7	71.7
08:25	F1	86.8	72.2	79.8	75.7	69.7	86.8	72.2
08:35	F1	86	71.1	79.7	75	68.4	86	71.1
08:45	F1	91.2	71.7	80.2	75.1	68.7	91.2	71.7
08:55	F1	89	71.9	80.2	75.5	69.3	89	71.9
09:05	F1	90.6	71.4	80.1	74.7	68.2	90.6	71.4
09:15	F1	86.4	71.3	79.8	75	68.4	86.4	71.3
09:25	F1	82.8	70.9	79.6	74.9	68	82.8	70.9
09:35	F1	83.8	70.1	78.4	73.7	67.4	83.8	70.1
09:45	F1	81.1	69.1	77.3	73	66.4	81.1	69.1
09:55	F1	88	71.2	80.8	74.5	67.3	88	71.2
10:05	F1	82.6	69.7	77.8	73.3	67.1	82.6	69.7
10:15	F1	92.7	70.4	78.9	73.6	67.5	92.7	70.4
10:25	F1	87.3	71.4	82	74.3	67.4	87.3	71.4
10:35	F1	91.9	70.7	77.8	73.4	66.9	91.9	70.7
10:45	F1	83.8	70.2	79.6	73.2	67.5	83.8	70.2
10:55	F1	85	70.6	80	73.9	67.9	85	70.6
11:05	F1	87.7	70.6	78.9	73.9	67.6	87.7	70.6

Table A: Tabulated fixed monitoring measurements results



Start	Position	Time	L _{Amax}	L _{Aeq}	L _{A1}	L _{A10}	L _{A50}	L _{A90}
21 st February 2019 Day								
11:21'34	2	00:05'00	77.4	63.7	71.9	67.5	60.7	53.9
11:26'34	2	00:05'00	74.7	64.1	71.9	68.2	61	53.7
11:31'34	2	00:05'00	76.7	64.4	72.5	68.1	61.6	55
11:36'34	2	00:05'00	76.3	62.4	70.2	66.6	59.2	54.7
11:41'34	2	00:05'00	78.1	62.7	72	65.9	59.5	53.1
11:46'34	2	00:05'00	72.2	61.9	69.8	65.9	58.9	53.6
11:52'42	2	00:05'00	73	63.5	70.9	67.1	61.8	53.2
11:59'34	2	00:05'00	85.2	63.8	71.4	66.8	61	54.2
12:06'14	3	00:05'00	63.6	54.1	60.3	57.2	52.9	48.6
12:11'14	3	00:05'00	62.5	54.2	60.2	57.6	52.7	47.8
12:16'14	3	00:05'00	65.7	53.8	61.3	57.1	51.9	47.2
12:21'14	3	00:05'00	68.5	56.1	64.4	59.4	54	47.7
12:26'14	3	00:05'00	70.9	55.6	63.9	58.4	53.5	48.7
12:31'14	3	00:05'00	68.4	55.5	62.7	58.6	53.7	49.4
12:36'14	3	00:05'00	67.3	54.6	62.3	58	52.5	47.1
12:41'14	3	00:05'00	76.5	54.8	61.6	58	52.5	48.2
12:46'14	3	00:05'00	66.7	55.7	62.5	58.5	54.4	50.2
12:51'14	3	00:05'00	66.8	56.2	64.6	58.9	54.3	51
12:56'14	3	00:05'00	64.4	55.3	61.6	58.2	54.1	50.3
13:01'28	3	00:01'52	70	58.3	68.1	60.6	55.7	51.6
13:04'14	4	00:05'00	66.6	48.6	57.8	49.5	46.2	43.3
13:09'14	4	00:05'00	55.8	45.2	51.1	46.8	44.6	42.3
13:14'14	4	00:05'00	54.1	45.3	50.7	47.6	44.6	42.2
13:19'14	4	00:05'00	54.2	46.5	52.8	50.2	44.9	42
13:24'14	4	00:05'00	56.3	47.9	54.8	51.5	45.9	42.2
13:30'44	4	00:05'00	74.4	51.3	63.2	48.1	44.6	42.1

Table B: Results taken from fixed position measurements