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Firhouse Residential Development

Firhouse, Dublin 24

Planning Stage Noise Assessment

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Report Author: Kevin Lynch

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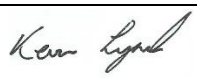
Signed:	

Date:	11th May 2022

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1	11/05/2022	Draft	Stephen Kearney BE MIEI MIOA	
2				
3				
4				

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Glossary of Terminology

L_{Aeq}: Equivalent Continuous A-weighted Sound Level. The continuous steady noise level, which would have the same total A-weighted acoustic energy as the real fluctuating noise measured over the same period of time.

L_{A90}: The A-weighted noise level that is equalled or exceeded for 90% of the measurement period. This is typically used to indicate the background noise level at a location.

L_{A10}: The A-weighted noise level that is equalled or exceeded for 10% of the measurement period.

L_{Amax}: The A-weighted maximum instantaneous noise level that is measured throughout a noise measurement.

1 Introduction

Allegro Acoustics was commissioned by Tom Phillips and Associates to carry out a noise assessment as part of a planning application for a residential development (Planning Application Number: ABP-311459-21). The development site is located on the Firhouse Road, Firhouse, Dublin 24. The proposed development is for the construction of 2no. apartment blocks between three to five storeys high, comprising of 100no. residential units, a creche and commercial units at ground floor level, public and communal open spaces and all associated site works and infrastructure. Vehicular and pedestrian access is proposed via an existing access point on the Firhouse Road along the southern site boundary. The proposed development is shown in Figure 1 below.

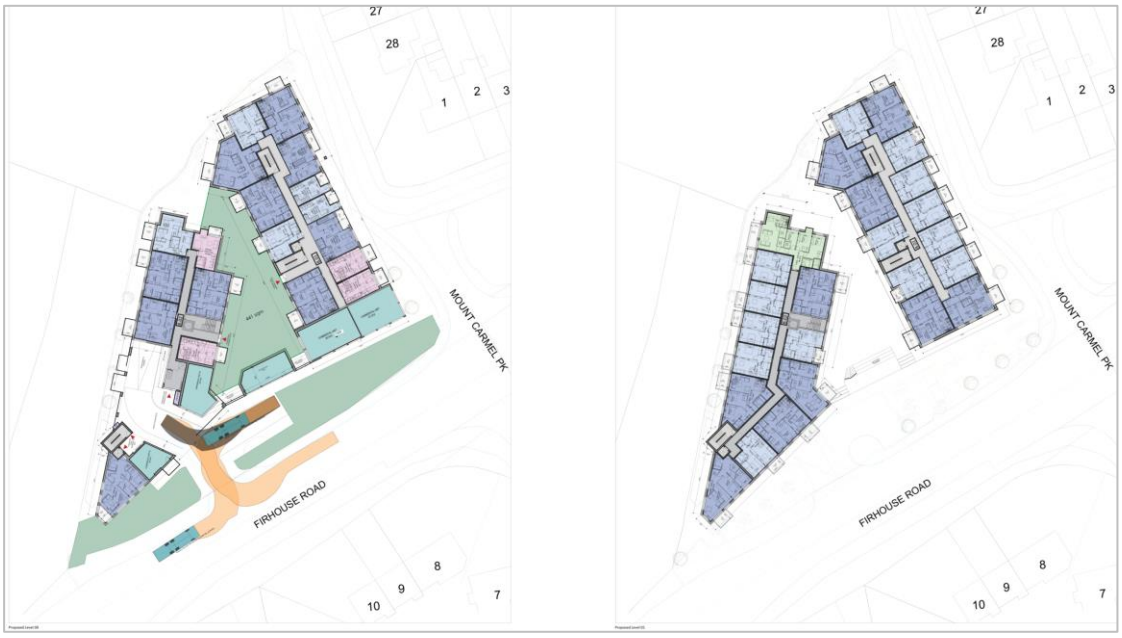


Figure 1: Drawing showing the proposed residential development.

The purpose of the noise assessment detailed in this report is to address the potential noise impact from the development. The following items have been assessed and are discussed in this report:

- Existing baseline noise levels.
- Construction noise limits and noise control methodology.
- Operational phase noise sources including traffic noise, M&E plant noise and noise associated with the proposed creche, playground and commercial units.
- Regulatory compliance with Technical Guidance Document E, Sound [1].
- The acoustic comfort of occupants of the residential development and the creche as per BS 8233 [2] and As NZS 2107 [3].

2 Suitably Qualified Consultant

The following project team carried out this assessment:

- Acoustic Consultant: Kevin Lynch
- Principal Acoustic Consultant: Stephen Kearney

The qualifications for the project team are summarised in Table 1 below. It is proposed that the project team has sufficient qualifications and experience to meet the requirement of a suitably qualified acoustic consultant.

Suitably Qualified Acoustic Consultant
Kevin Lynch BE MIEI *Acoustic Consultant at Allegro Acoustics, 2020 to Present* Project Role: Assessment and Reporting. Qualifications: • Currently Completing a Postgraduate Diploma in Acoustics and Noise Control from Trinity College Dublin and the Institute of Acoustics (IOA) • Bachelor's Degree in Mechanical Engineering from National University of Ireland, Galway (2020)
Stephen Kearney BE MIEI MIOA *Principal Acoustic Consultant at Allegro Acoustics, 2014 to Present* Project Role: Report Review. Qualifications: • Postgraduate Diploma in Acoustics and Noise Control from Trinity College Dublin and the Institute of Acoustics (IOA) (2016) • Bachelor's Degree in Energy Systems Engineering from National University of Ireland, Galway (2014)

Table 1: Summary of the qualifications of the project team.

3 Baseline Noise Levels

Allegro Acoustics carried out a manned noise survey at two locations on the 26th of April 2022 to determine the existing baseline noise levels at the site of the proposed development. Noise monitoring was carried out according to the methodologies outlined in the following standards:

- International Standards Organization, *ISO 1996 Acoustics – Description and Measurement of Environmental Noise* [4].
- Environmental Protection Agency, *Guidance Note for Noise: License Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)* [5].

The noise monitoring locations denoted as N1, N2 and N3 are shown on a satellite image of the site in Figure 2 below.

Figure 2: Satellite image showing noise monitoring locations N1, N2 and N3 in relation to the proposed site boundary.

Noise monitoring was carried out at each location during day, evening and night time hours. As per the guidance provided by the Environmental Protection Agency in *Guidance Note for Noise (NG4)* [5], day, evening and night time periods are defined as follows:

- Day: 07:00 - 19:00
- Evening: 19:00 - 23:00
- Night: 23:00 - 07:00

Weather conditions were observed to be conducive to noise monitoring throughout the noise survey (wind <5m/s, rain <1mm per hour [2]). The characteristics of the noise environment are described in Table 2 below. The results of the noise survey are presented in Table 3 and Figure 3 below. A detailed table of results is also included Appendix A.

Characteristics of the Noise Environment		
Location	Period	Observations
N1	Day	The primary noise source during the day time measurement at monitoring location N1 was observed to be traffic noise from the surrounding road network. Additional noise sources included birdsong, and infrequent car movement in the adjacent car park.
N1	Evening	The primary noise source during the evening time measurement at monitoring location N1 was observed to be traffic noise from the surrounding road network. Additional noise sources included birdsong.
N1	Night	The primary noise source during the night time measurement at monitoring location N1 was observed to be traffic noise from the surrounding road network.

Characteristics of the Noise Environment		
Location	Period	Observations
N2	Day	The primary noise source during the day time measurement at monitoring location N2 was observed to be traffic noise from the surrounding road network, and the adjacent Firhouse Road. Additional noise sources included birdsong, and a plane passing overhead.
N2	Evening	The primary noise source during the evening time measurement at monitoring location N2 was observed to be traffic noise from the surrounding road network, and the adjacent Firhouse Road. Additional noise sources included pedestrians, and a helicopter passing overhead.
N2	Night	The primary noise source during the night time measurement at monitoring location N2 was observed to be traffic noise from the surrounding road network, and light traffic on the adjacent Firhouse Road.
N3	Day	The primary noise source during the day time measurement at monitoring location N3 was observed to be traffic on the nearby M50. Additional noise sources included birdsong.
N3	Evening	The primary noise source during the evening time measurement at monitoring location N3 was observed to be traffic on the nearby M50.
N3	Night	The primary noise source during the night time measurement at monitoring location N3 was observed to be traffic on the nearby M50.

Table 2: Characteristics of the noise environment as observed during the noise survey.

Measured Noise Levels									
Location	Meas No.	Start Time	Period	Duration	L_{Aeq}	L_{A90}	L_{A10}	L_{Amax}	L_{Amin}
					dB	dB	dB	dB	dB
N1	Meas001	26/04/2022 12:03	Day	00:30:00	59.6	57.5	61.1	68.9	55.1
N1	Meas004	26/04/2022 19:41	Eve	00:30:00	57.4	54.7	59.1	73.6	52.0
N1	Meas007	26/04/2022 23:00	Night	00:30:00	51.1	47.5	53.4	65.4	43.5
N2	Meas002	26/04/2022 12:34	Day	00:30:00	68.0	61.9	71.1	87.3	58.6
N2	Meas005	26/04/2022 20:13	Eve	00:30:00	67.1	59.7	70.3	84.8	55.8
N2	Meas008	26/04/2022 23:31	Night	00:30:00	62.0	52.7	63.9	83.2	49.3
N3	Meas003	26/04/2022 13:06	Day	00:10:00	64.9	62.5	67.0	70.8	59.8
N3	Meas006	26/04/2022 20:48	Eve	00:10:00	62.0	59.9	63.5	65.7	56.9
N3	Meas009	27/04/2022 00:03	Night	00:10:00	56.1	52.2	58.6	66.3	48.1

Table 3: Measured noise levels at the site of the proposed development.

The 1/3rd Octave frequency breakdown for each measurement has been assessed for tonality using the 1/3rd Octave method outlined by the Environmental Protection Agency in *Guidance Note for Noise (NG4)* [5]. Using this methodology, the background noise environment at the site of the proposed development was not observed to have any significant tonal or impulsive characteristics. Background noise is typically depicted using the dB L_{90} statistical indicator [6].

The measured 1/3rd octave dB L_{eq} and dB L_{90} values for each measurement are shown in Figure 3 below. A detailed table of results is also included Appendix A.

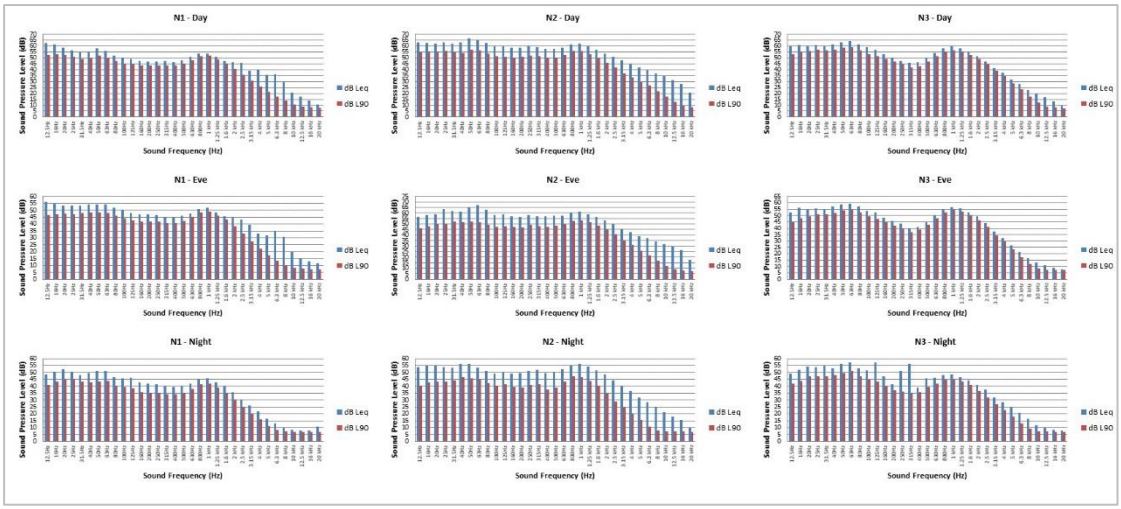


Figure 3: Graphical representation of the measured 1/3rd octave dB L_{eq} and dB L_{90} values for each measurement. This data is included in tabular format in Appendix A.

4 Construction Noise

Noise sensitive locations have been identified in close proximity to site of the proposed development. These noise sensitive locations include residential dwellings to the east and south of the site. Construction noise will be strictly controlled throughout this development to protect these noise sensitive locations.

Allegro Acoustics proposes that the construction noise limits outlined by The National Roads Authority in *Guidelines for the Treatment of Noise and Vibration in National Road Schemes* [7] are appropriate to apply to this development. While these limits relate to road schemes, in the absence of any statutory guidelines in the Republic of Ireland relating to noise limits for housing developments, these noise limits are considered to be the most appropriate construction noise limits for this development.

Proposed Construction Noise Limits		
Day & Times	dB $L_{Aeq\ (1hr)}$	dB L_{Amax}
Monday – Friday (07:00 to 19:00)	70	80
Monday – Friday (19:00 to 22:00)	60	65
Saturday (08:00 to 16:30)	65	75
Sundays and Bank Holidays (08:00 to 16:30)	60	65

Table 4: Proposed construction noise limits for this development as per the guidelines outlined by the National Roads Authority [7].

These noise limits will be enforced using continuous noise monitoring during the construction phase of this project at two locations on the proposed site boundary. These proposed monitoring locations are outlined in Figure 4 below. The noise monitoring stations used will be equipped with real time text / email alerts to notify the site team as soon as an exceedance takes place. This will allow the contractor to investigate the cause of the exceedance and take action immediately to reduce the noise levels to below the level outlined in Table 4 above.

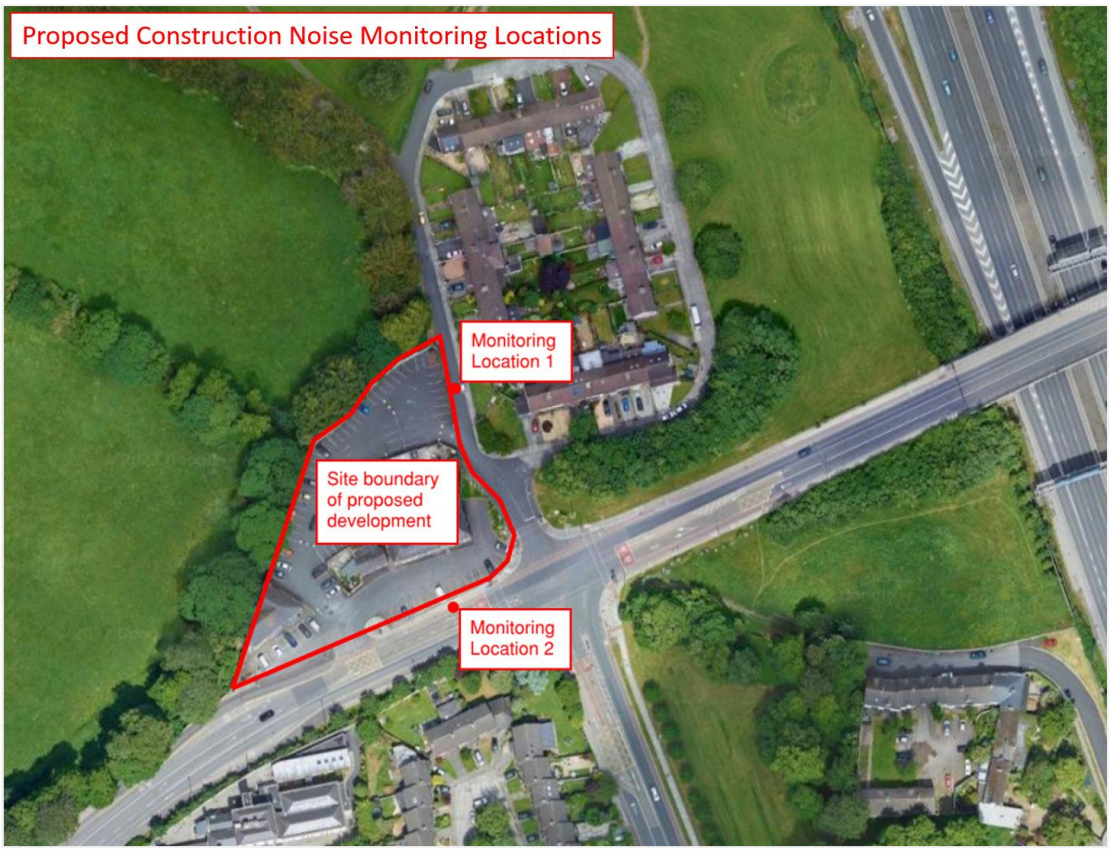


Figure 4: Satellite image showing the proposed construction stage noise monitoring locations in relation to the proposed site boundary.

The good practice measures outlined in *BS 5228-1 + A1 Code of practice for noise and vibration control on construction and open sites* [8] will also be implemented at this site as appropriate to control and minimise the impact of construction noise on the surrounding noise environment. These measures are summarised as follows:

- A site representative responsible for matters relating to noise will be appointed at the start of the construction phase of the project.
- Channels of communication between the contractor and the nearby noise sensitive locations will be established. This will allow for the maintenance of good relations and clear channels of communication between the contractor and the occupants of the nearby noise sensitive buildings.
- Plant equipment with low inherent potential for generation of noise will be selected where practical.
- Where earth movers dump material into dumper trucks, the material fall height will be minimised as much as practical so that noise generation is minimised.
- Mufflers and silencers will be fitted to constant noise sources such as vehicular machinery and generators where required.
- Machinery will be switched off when it is not in use instead of leaving it on idle.
- As far as reasonably practical, sources of significant noise will be enclosed. Acoustic screens will be used close to noisy operations where required.

- Temporary hoarding will be erected around items such as generators or high duty compressors where required.
- Noisy plant will be located as far away from noise sensitive facades as practical and as permitted by site constraints.
- Diesel engines will be substituted with electric motors where practical.

5 Operational Noise

The primary noise sources during the operational phase of this development are identified as follows:

- Increased traffic volume from the development.
- Plant noise from M&E plant items associated with the development.

These items are discussed individually in subsections 5.1 and 5.2 below.

Additional everyday domestic noise sources such as waste collection, pedestrians etc. are generally considered part of everyday living and are generally not considered in the context of noise nuisance.

5.1 Increased Traffic Volume

It is noted that the addition of 100no. residential units and a childcare facility will result in an increased traffic volume to the area. As shown in Figure 1 above, the site for this development is located in a suburban setting with residential dwellings to the east and south of the site. As outlined in Table 2 above, the existing noise environment at this site is characterised by traffic noise from the surrounding road network. As such, it is concluded that the additional noise created by traffic servicing this development during the operational phase will not be out of place in the context of the existing noise environment.

A peak traffic assessment carried out by Transport Insights concluded that the peak hour 2-way traffic flows along the Firhouse Road are predicted to increase by a maximum of 4.3% as a result of this development. Using a logarithmic comparison (N = 10Log(L2/L1)), it is calculated that an 4.3% increase in peak traffic volume will result in a 0.18dB increase in the dB L_{A10} noise level in the vicinity of the Firhouse Road, during peak traffic hours.

As per the guidance outlined in the *UK Design Manual for Roads and Bridges, Volume 11, Section 3, Part 7* [9], an increase in the traffic noise levels of less than 0.9dB dB $L_{A10,18h}$ is considered negligible in the context of both the short term (year the project is opened) and the long term (15 years after the project is opened). This is shown in Figure 5 below.

Noise change, $L_{A10,18h}$	Magnitude of Impact
0	No change
0.1 – 0.9	Negligible
1 – 2.9	Minor
3 – 4.9	Moderate
5+	Major

Table 3.1 – Classification of Magnitude of Noise Impacts in the Short Term

Noise change, $L_{A10,18h}$	Magnitude of Impact
0	No change
0.1 – 2.9	Negligible
3 – 4.9	Minor
5 – 9.9	Moderate
10+	Major

Table 3.2 – Classification of Magnitude of Noise Impacts in the Long Term

Figure 5: Extract from the *UK Design Manual for Roads and Bridges, Volume 11, Section 3, Part 7* [9].

5.2 M&E Plant Noise

Noise emitting items of external M&E Plant may be introduced to this development during the design phase. These items of plant could include air / ground source heat pumps, air handling equipment etc. Based on measured noise levels, it is not considered at this stage that the building will need to be mechanically ventilated for acoustic reasons. As such, a significant amount of M&E plant is not expected for this building. Should these items be introduced during the design phase of this project, the specific noise level from plant installed in the residential development will achieve the day, evening and night time noise limits set out by the EPA in *Guidance Note for Noise* [5] at all nearby residential receptors. These noise emission limit values are displayed in Table 5 below.

Proposed Noise Limits for M&E Plant	
Period	Noise Emission Limit Value
Daytime (07:00 to 19:00hrs)	55 dB $L_{Ar,T}$
Evening (19:00 to 23:00hrs)	50 dB $L_{ar,T}$
Night Time (23:00 to 07:00hrs)	45 dB $L_{eq,T}$ & no tonality

Table 5: Proposed noise limits for M&E Plant associated with the development.

Operational phase M&E plant noise will be attenuated as required to ensure that these noise limits are achieved at the closest noise sensitive location to the item of plant in question. This will be verified during the design stage using a 3D environmental noise model of the building.

6 Acoustic Comfort

The development will be designed to provide the appropriate level of acoustic comfort to the users of the residential development and the childcare facility. This is discussed in subsections 6.1 – 6.4 below.

6.1 Residential Development

6.1.1 Façade Performance

The glazing and façade for each space will be specified and designed so that the internal noise levels meet the recommended indoor ambient noise level for dwellings as outlined in *BS 8233 Guidance on sound insulation and noise reduction for buildings* [2].

Table 4 **Indoor ambient noise levels for dwellings**

Activity	**Location**	**07:00 to 23:00**	**23:00 to 07:00**
Resting	Living room	35 dB $L_{Aeq,16hour}$	—
Dining	Dining room/area	40 dB $L_{Aeq,16hour}$	—
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

Figure 6: Extract from *BS 8233 Guidance on sound insulation and noise reduction for buildings* [2].

An indicative level of the level of sound insulation performance required from the building façade to achieve the criteria proposed in Figure 6 above is provided in Figure 7 below. This e level of performance is based on the measured baseline noise levels presented in Section 3 above. A detailed façade assessment will be carried out during the design phase of this project.

Figure 7: Indicative façade insulation sound insulation requirements.

Sample glazing and ventilator products and build-ups to achieve the sound insulation specification outlined in Figure 7 above are provided in Table 4 below.

Performance Specification for the Façade Glazing and Background Ventilators	
Criteria	Sample Build-up
Legend Colour (Figure 8 above): ■ ■ Glazing and Frame rated to achieve a minimum of: **≥39dB $R_w + C_{tr}$** Trickle Vent to achieve a minimum of: **≥44dB $D_{n,e,w} + C_{tr}$** When the ventilator is in the open position.	**Example Glazing Product:** Pilkington Optiphon 10mm / 20mm Argon / 8.8mm Pilkington Optiphon www.pilkington.com **Example Background Ventilator:** Duco DucoMax SR Largo 10 www.duco.eu
Legend Colour (Figure above): ■ ■ Glazing and Frame rated to achieve a minimum of: **≥35dB $R_w + C_{tr}$** Trickle Vent to achieve a minimum of: **≥41dB $D_{n,e,w} + C_{tr}$** When the ventilator is in the open position.	**Example Glazing Product:** Pilkington Optiphon 6mm / 16mm Argon / 8.8mm Pilkington Optiphon www.pilkington.com **Example Background Ventilator:** Duco DucoMax SR Largo 10 www.duco.eu

Performance Specification for the Façade Glazing and Background Ventilators	
Criteria	Sample Build-up
Legend Colour (Figure 7 and 8 above): Glazing and Frame rated to achieve a minimum of: **≥31dB R_w + C_{tr}** Trickle Vent to achieve a minimum of: **≥37dB $D_{n,e,w}$ + C_{tr}** When the ventilator is in the open position.	**Example Glazing Product:** Pilkington Double Glazed Insulating Glass Unit 10mm / 6-16mm Argon / 6mm Glass www.pilkington.com **Example Background Ventilator:** Duco DucoMax SR Alto 15 www.duco.eu

Table 6: Example build-ups for estimated glazing requirements, and acoustic ventilators.

6.1.2 Walls and Floors

The separating walls and floors in the residential dwellings will be designed and specified so that the criteria outlined in Requirement E1 of *Technical Guidance Document E* [1] is achieved. This will be achieved using appropriate wall and floor build ups to be specified during the design stage of this project.

Table 1	**Sound performance levels** (*Par. 1.1.1*)	
Separating construction	**Airborne sound insulation $D_{nT,w}$ dB**	**Impact sound insulation $L'_{nT,w}$ dB**
Walls	53 (min)	-
Floors (including stairs with a separating function)	53 (min)	58 (max)

Figure 8: Extract from *Technical Guidance Document E* [1].

6.1.3 Reverberation Control

The sound absorption strategy in common areas throughout this development will be designed and specified so that the criteria outlined in Requirement E2 of *Technical Guidance Document E* [1] is achieved. This will be done using a sound absorbing ceiling finish as per either Method A or Method B as described in *Technical Guidance Document E* [1].

Reverberation.	E2	The common internal part of a building which provides direct access to a dwelling shall be designed and constructed so as to limit reverberation in the common part to a reasonable level

Figure 9: Extract from *Technical Guidance Document E* [1].

6.2 Creche

The internal noise level criteria, the glazing and façade performance, the internal sound insulation performance and the sound absorption strategy for the creche will be specified using appropriate acoustic standards and guideline documents such as:

- *BS 8233 Guidance on sound insulation and noise reduction for buildings* [2]
- *AS / NZS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors* [3].

6.3 Noise from Playground

Potential noise nuisance from the playground has been assessed as part of this planning submission. Based on the noise level for a "play and sports area with modest noise" outlined in the SoundPLAN V7.3 noise emissions library, a façade with a rating of ≥31dB R_w is required to achieve the daytime (07:00 – 23:00) noise criteria of 35dB L_{Aeq} as outlined in Section 6.1 above for apartments. This level of performance is provided by all of the façade specification outlined in Section 6.1.1 above.

6.4 Noise from Commercial Units

6.4.1 Breakout through floor slab.

As a good practice measure, a floor build up achieving ≥57dB $D_{nT,w}$ will be used between the commercial units and the apartments above these units. This level of performance minimises the likelihood of noise transfer between these parts of the building. Table 7 below outlines a suitable build up to achieve this level of performance.

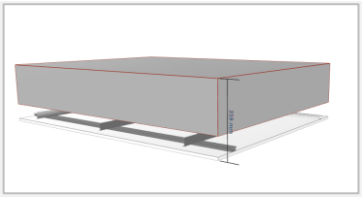
Proposed Floor Buildup		
Construction Details	Predicted Sound Insulation Performance (Insul V9.0)	Graphic
• 250mm Cast Concrete • 12.5mm Plasterboard Ceiling Suspended Using a Metal Grid Ceiling (≥100mm Void)	66dB R_W (61dB $D_{nT,w}$)	

Table 7: Recommended sample ceiling build-up between commercial units and residential units.

6.4.2 Noise from Deliveries

Considering the existing traffic noise level in the area, noise from delivery vehicles and / or staff / patrons to the commercial facilities and crèche is not likely to be out of place in the context of the existing noise environment. It is recommended that deliveries take place during day time hours only (07:00 – 23:00). The façade specification outlined in Section 6.1.1 will offer a high level of sound insulation performance so the potential noise intrusion from delivery vehicles is expected to be minimal.

7 Summary and Conclusion

Allegro Acoustics has carried out a noise assessment in Firhouse, Dublin 24 as part of a planning application for the development of 100no. residential units, 3no. commercial units and a creche. This assessment is summarised as follows:

- A manned baseline noise survey confirms that the noise environment at this site is characterised by road traffic noise from the surrounding road network.
- Construction noise limits, noise monitoring methodology and good practice measures have been provided in Section 4 above to protect nearby noise sensitive locations during the construction phase of this project.
- It has been deduced in Section 5.1 above that the additional noise created by traffic servicing this development during the operational phase will not be out of place in the context of the existing noise environment. Furthermore, the predicted increase in noise levels due to the increased traffic volume is considered to be negligible in the context of both the short term (year the project is opened) and the long term (15 years after the project is opened).
- Noise limits have been provided in Section 5.2 above to protect nearby noise sensitive locations from the risk of M&E plant noise during the operational phase of this development.
- Acoustic design criteria have been provided in Section 6 above to provide an appropriate level of acoustic comfort to the residents and users of this development.

8 References

[1] Department of Housing, Local Government and Heritage , “Building Regulations Technical Guidance Document E - Sound,” 2014.

[2] British Standards Institution, “BS 8233 Guidance on sound insulation and noise reduction for buildings,” 2014.

[3] Australian / New Zealand Standard, “AS/NZS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors,” 2016.

[4] International Standards Organisation, “ISO 1996-1 Acoustics - Description and measurent of environmental noise - Part 1: Basic quantities and assessment procedures,” 2016.

[5] Environmental Protection Agency, “Guidance Note for Noise: License Applications, Surveys and Assessments in Relation to Scheduled Activities,” 2016.

[6] British Standards Institution, “BS 4142 Method for rating and assessing industrial and commercial sound,” 2014.

[7] National Roads Authority, “Guidelines for the Treatment of Noise and Vibration in National Road Schemes,” 2004.

[8] British Standards Institution, “BS 5228-1 + A1 Code of practice for noise and vibration control on construction and open sites. Noise,” 2014.

[9] The Highways Agency UK, “HD 213/11 Design Manual for Roads and Bridges Volume 11, Section 3, Part 7, Revision 1,” November 2011.

[10] An Bord Pleanála, “Planning and Development (Housing) and Residential Tenancies Act 2016 Notice of Pre-Application Consultation Opinion Case Reference: ABP-311684-21,” December 2021.

Appendix A

L_{eq} and L_{90} 1/3rd Octave Frequency Data and Graphs

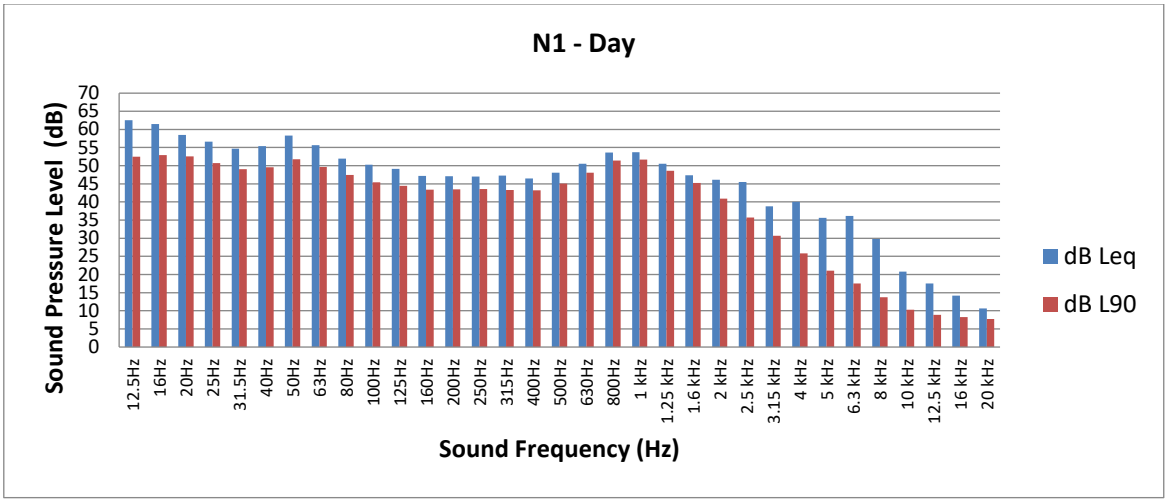


Figure A1: N1 Day time 1/3rd Octave Band Frequency Analysis

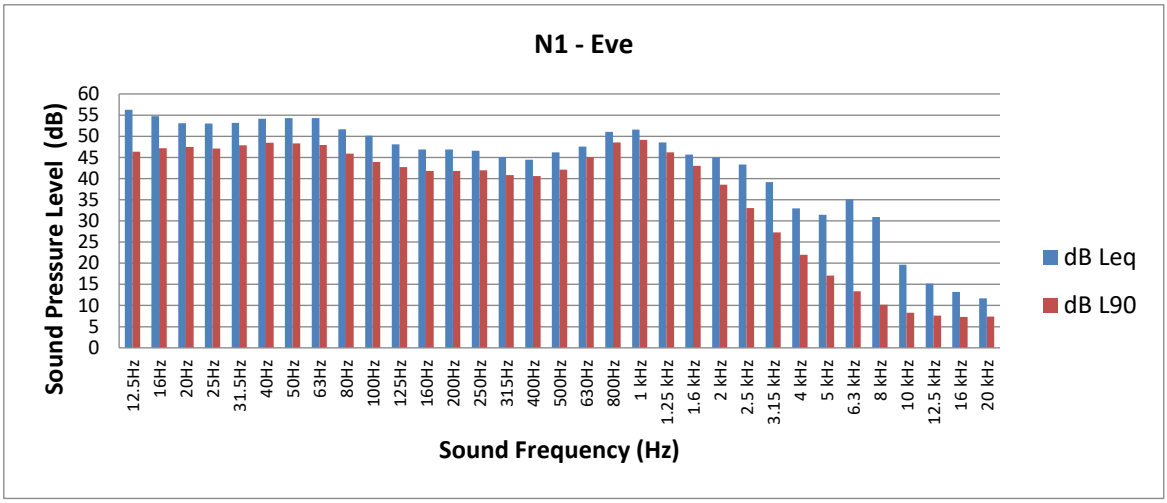


Figure A2: N1 Eve time 1/3rd Octave Band Frequency Analysis

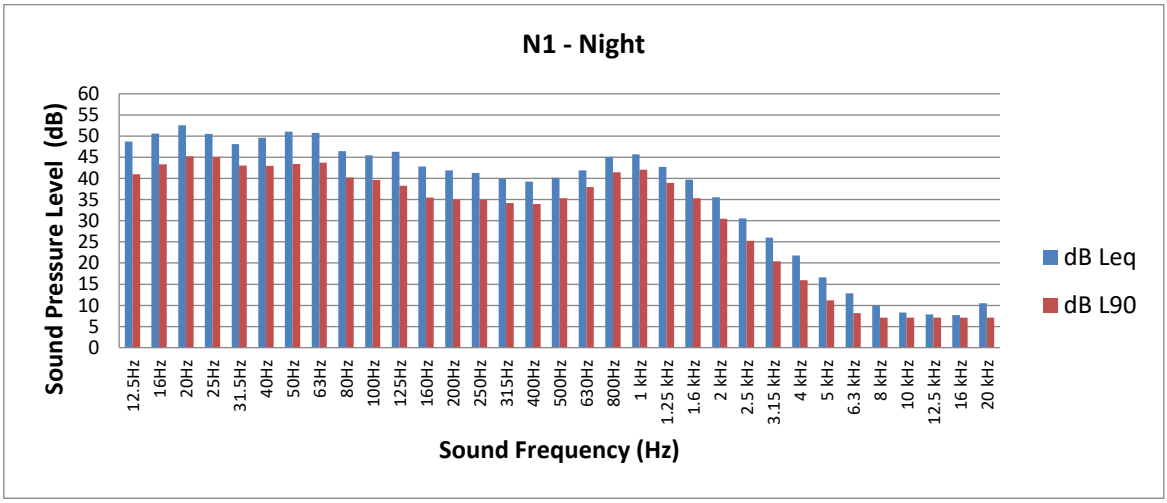


Figure A3: N1 Night time 1/3rd Octave Band Frequency Analysis

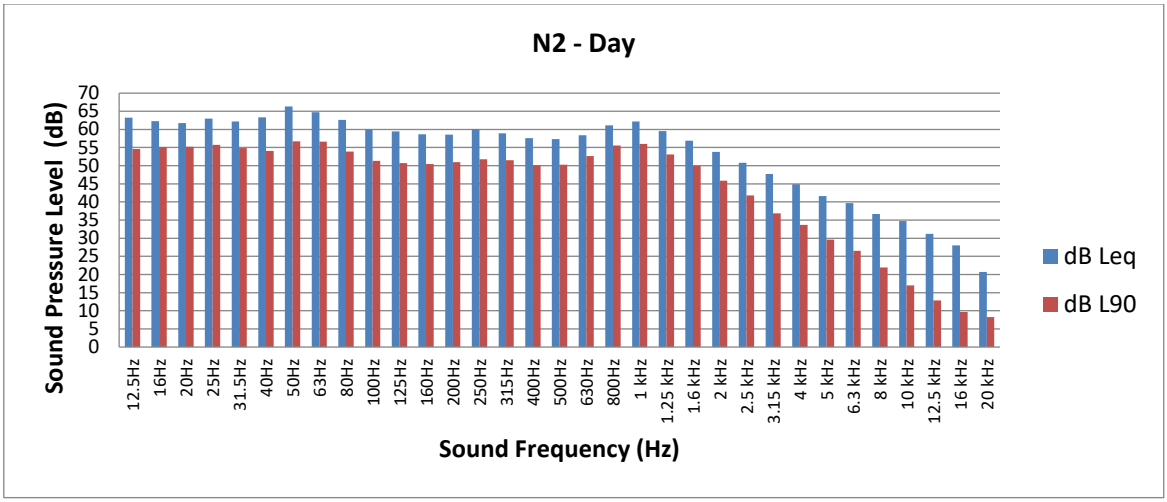


Figure A4: N2 Day time 1/3rd Octave Band Frequency Analysis

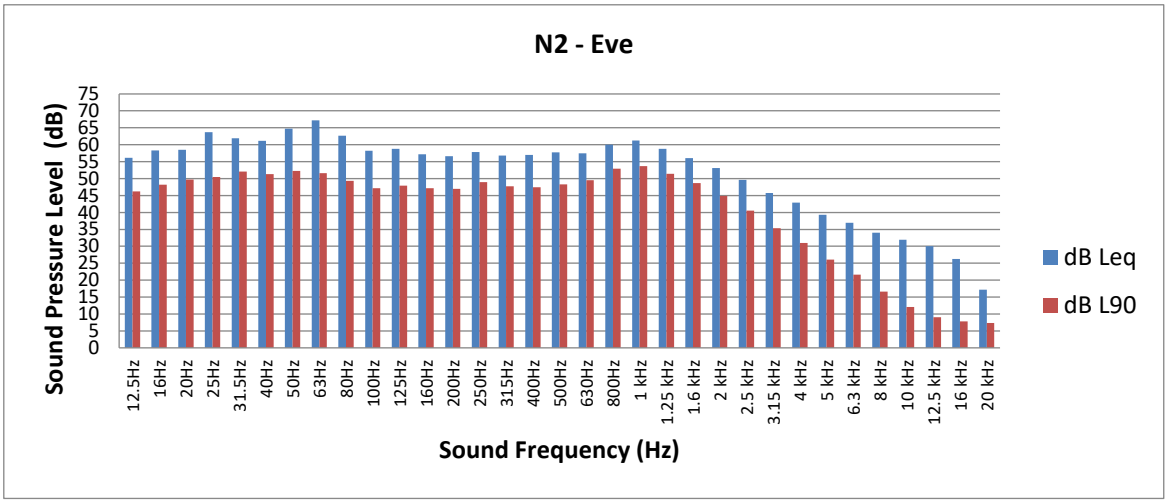


Figure A5: N2 Eve time 1/3rd Octave Band Frequency Analysis

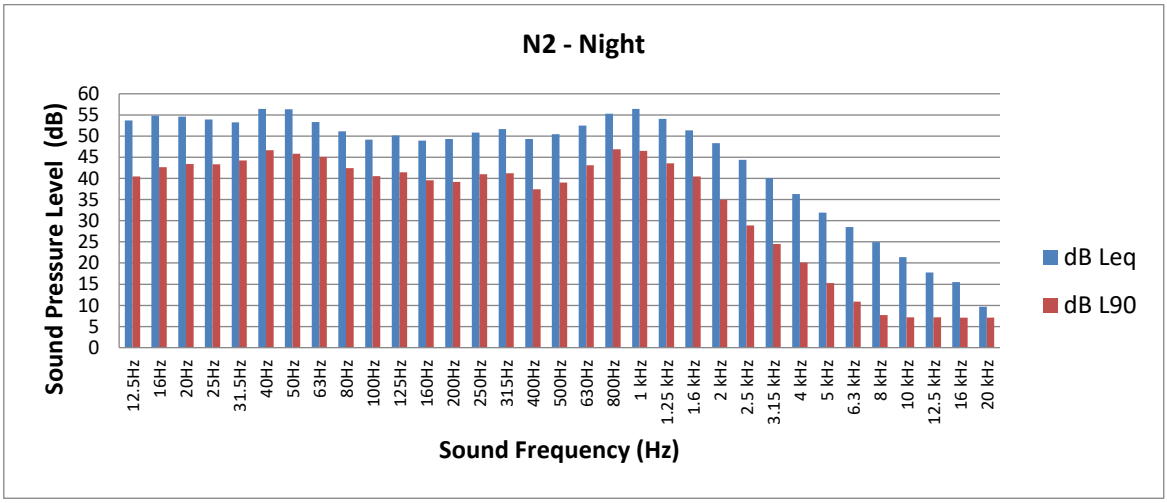


Figure A6: N2 Night time 1/3rd Octave Band Frequency Analysis

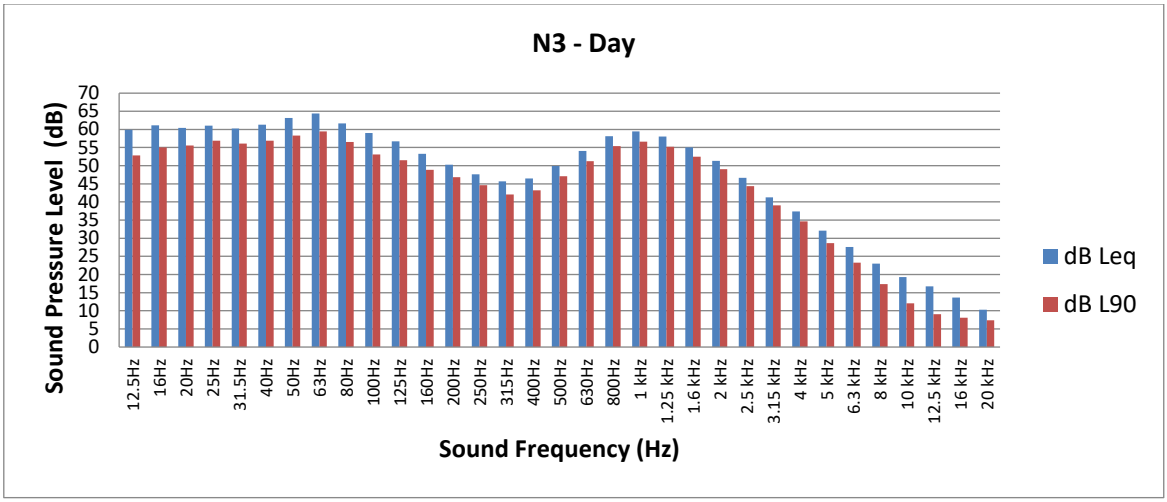


Figure A7: N3 Day time 1/3rd Octave Band Frequency Analysis

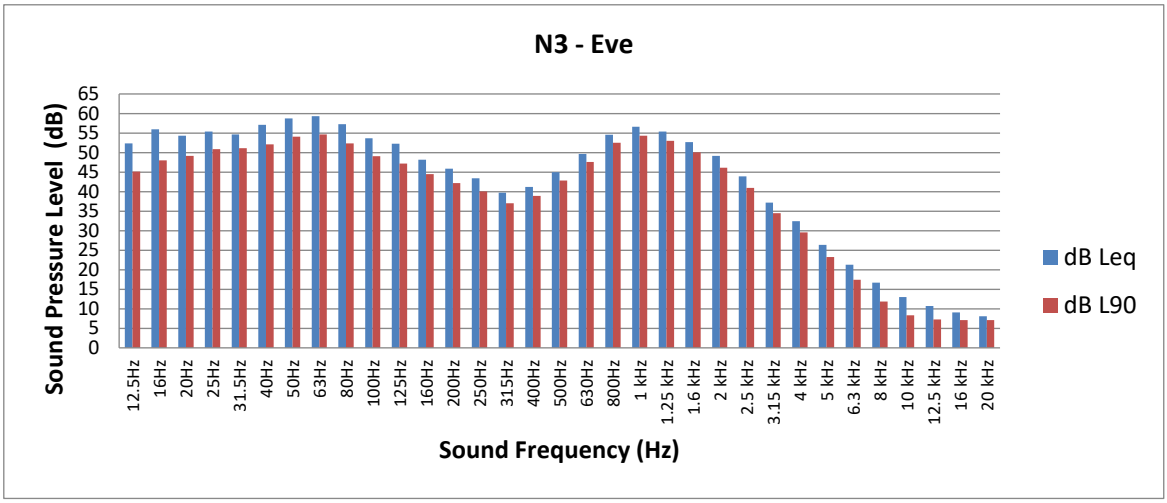


Figure A8: N3 Eve time 1/3rd Octave Band Frequency Analysis

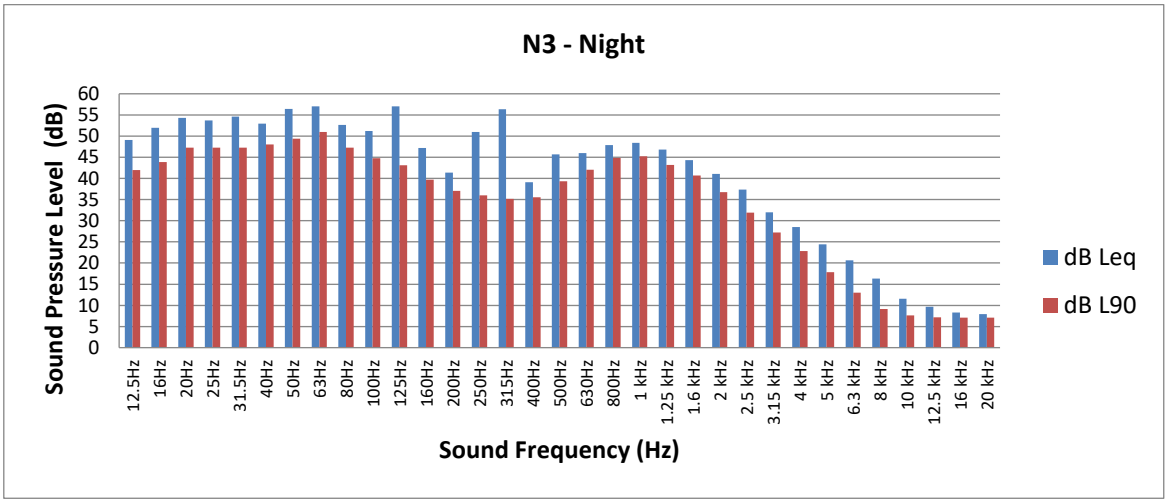


Figure A9: N3 Night time 1/3rd Octave Band Frequency Analysis

ALLEGRO acoustics

Brüel & Kjær

Testing Agency:	Allegro Acoustics
Testing Operator:	Kevin Lynch BE MIEI
SLM:	Bruel & Kjaer 2250
SLM Serial Number:	2722891
SLM Factory Calibration Date:	01/04/2022
Sound Field Correction:	Free Field
Bandwidth:	1/3rd Octave - Fully Integrating
Time Weighting:	Fast

dB Leq Measurement Data

Location	Period	Measurement	Start Time	Elapsed	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq	LZeq
				Time	12.5Hz	16Hz	20Hz	25Hz	31.5Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz	12.5 kHz	16 kHz	20 kHz
N1	Day	Meas001	26/04/2022 12:03	00:30:00	62.52	61.45	58.46	56.59	54.69	55.35	58.27	55.62	51.91	50.31	49.15	47.16	47.1	47	47.24	46.46	48.07	50.57	53.65	53.72	50.57	47.33	46.11	45.54	38.82	40.02	35.65	36.18	29.83	20.81	17.53	14.18	10.67
N1	Eve	Meas004	26/04/2022 19:41	00:30:00	56.23	54.77	53.09	53	53.14	54.11	54.28	54.29	51.62	50.13	48.06	46.91	46.9	46.56	45.08	44.46	46.18	47.56	51.01	51.55	48.58	45.64	45	43.35	39.17	32.94	31.47	35.08	30.9	19.66	15.15	13.23	11.68
N1	Night	Meas007	26/04/2022 23:00	00:30:00	48.74	50.61	52.59	50.54	48.13	49.63	51.05	50.72	46.41	45.44	46.25	42.77	41.93	41.32	39.92	39.22	40.12	41.89	45.09	45.65	42.74	39.68	35.55	30.57	25.98	21.77	16.66	12.88	9.86	8.3	7.83	7.72	10.5
N2	Day	Meas002	26/04/2022 12:34	00:30:00	63.21	62.24	61.73	63	62.19	63.32	66.33	64.77	62.62	59.96	59.46	58.62	58.55	60.06	58.93	57.58	57.37	58.4	61.17	62.17	59.57	56.9	53.77	50.79	47.72	44.9	41.59	39.67	36.7	34.75	31.25	28.04	20.73
N2	Eve	Meas005	26/04/2022 20:13	00:30:00	56.1	58.3	58.53	63.68	61.88	61.2	64.78	67.2	62.71	58.27	58.83	57.17	56.6	57.84	56.81	56.97	57.79	57.47	60.01	61.26	58.81	56.09	53.1	49.6	45.78	42.87	39.28	36.96	34.01	31.92	30.02	26.26	17.19
N2	Night	Meas008	26/04/2022 23:31	00:30:00	53.73	54.86	54.63	53.89	53.22	56.4	56.32	53.31	51.1	49.16	50.14	48.94	49.32	50.85	51.64	49.34	50.47	52.48	55.32	56.41	54.04	51.32	48.32	44.37	40.11	36.33	31.93	28.47	24.96	21.4	17.79	15.46	9.66
N3	Day	Meas003	26/04/2022 13:06	00:10:00	59.93	61.1	60.45	61.03	60.26	61.34	63.12	64.42	61.67	59.04	56.71	53.27	50.25	47.61	45.69	46.46	49.91	54.09	58.14	59.46	58	55.05	51.29	46.63	41.3	37.38	32.07	27.63	22.98	19.31	16.77	13.62	10.28
N3	Eve	Meas006	26/04/2022 20:48	00:10:00	52.37	55.96	54.33	55.34	54.67	57.13	58.75	59.34	57.3	53.68	52.24	48.15	45.84	43.39	39.76	41.2	44.93	49.63	54.57	56.57	55.4	52.71	49.11	43.9	37.19	32.41	26.38	21.25	16.69	13.03	10.72	9.08	8.09
N3	Night	Meas009	27/04/2022 00:03	00:10:00	49.08	51.94	54.27	53.7	54.6	52.94	56.42	57.01	52.61	51.2	57.04	47.18	41.4	50.96	56.31	39.08	45.65	45.97	47.86	48.38	46.83	44.33	41.08	37.36	31.98	28.53	24.42	20.61	16.34	11.57	9.67	8.34	7.92

dB L90 Measurement Data

Location	Period	Measurement	Start Time	Elapsed	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90	LZ90
				Time	12.5Hz	16Hz	20Hz	25Hz	31.5Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz	12.5 kHz	16 kHz	20 kHz
N1	Day	Meas001	26/04/2022 12:03	00:30:00	52.49	52.91	52.55	50.73	49.02	49.56	51.77	49.62	47.41	45.45	44.47	43.43	43.51	43.57	43.33	43.25	45.07	48.05	51.43	51.67	48.56	45.24	40.92	35.7	30.65	25.79	21.09	17.53	13.73	10.33	8.91	8.23	7.75
N1	Eve	Meas004	26/04/2022 19:41	00:30:00	46.38	47.17	47.5	47.1	47.86	48.49	48.33	47.96	45.91	43.93	42.73	41.8	41.78	41.94	40.8	40.63	42.15	45.04	48.55	49.13	46.18	43.02	38.55	33.07	27.28	22.02	17.07	13.39	10.19	8.27	7.6	7.35	7.4
N1	Night	Meas007	26/04/2022 23:00	00:30:00	41	43.35	45.22	45.07	43.03	42.99	43.41	43.72	40.21	39.64	38.29	35.5	35.01	34.9	34.18	33.96	35.31	37.93	41.46	42.04	38.95	35.32	30.46	25.22	20.39	15.98	11.17	8.12	7.13	7.11	7.1	7.1	7.1
N2	Day	Meas002	26/04/2022 12:34	00:30:00	54.61	55.17	55.24	55.76	54.86	54.07	56.73	56.64	53.85	51.29	50.73	50.47	50.95	51.73	51.47	50.09	50.3	52.66	55.6	55.97	53.13	49.93	45.89	41.76	36.85	33.69	29.66	26.57	21.94	17.04	12.86	9.64	8.23
N2	Eve	Meas005	26/04/2022 20:13	00:30:00	46.26	48.21	49.68	50.5	52.06	51.36	52.29	51.57	49.37	47.17	47.89	47.15	46.98	48.94	47.7	47.41	48.27	49.54	52.95	53.64	51.41	48.64	44.86	40.56	35.3	30.97	26.07	21.61	16.61	12.06	9.03	7.86	7.32
N2	Night	Meas008	26/04/2022 23:31	00:30:00	40.49	42.68	43.42	43.37	44.24	46.68	45.83	45.1	42.42	40.5	41.43	39.54	39.19	40.99	41.25	37.41	39.01	43.13	46.91	46.54	43.56	40.44	34.92	28.9	24.48	20.11	15.28	10.88	7.69	7.18	7.15	7.13	7.11
N3	Day	Meas003	26/04/2022 13:06	00:10:00	52.81	55.07	55.56	56.89	56.12	56.91	58.33	59.41	56.54	53.09	51.5	48.86	46.85	44.58	42.09	43.24	47.07	51.23	55.35	56.61	55.21	52.46	49.01	44.38	39.08	34.63	28.66	23.28	17.36	12.03	9.06	8.09	7.4
N3	Eve	Meas006	26/04/2022 20:48	00:10:00	45.17	47.98	49.12	50.83	51.12	52.12	54.03	54.6	52.35	49.09	47.2	44.48	42.15	40.04	36.99	38.93	42.85	47.56	52.49	54.32	53.01	50.09	46.14	40.94	34.44	29.54	23.24	17.42	11.86	8.36	7.24	7.12	7.1
N3	Night	Meas009	27/04/2022 00:03	00:10:00	42	43.85	47.29	47.24	47.25	48.01	49.38	51	47.28	44.74	43.1	39.69	37.07	36	35.16	35.55	39.34	42.02	44.86	45.2	43.19	40.67	36.72	31.94	27.19	22.85	17.84	13.01	9.14	7.59	7.14	7.11	7.1

Appendix B

Calibration Certification

SONITUS SYSTEMS

Statement of Calibration

Issued to:

Allegro Acoustics
South City Business Park
Tallaght
Dublin 24

Calibration Reference
SLM220158

Test Date: 01/04/2022
Procedure: TP-SLM-1

Equipment

Item Calibrated:	Sound Level Meter	**Model**	Type 2250
Make:	Bruel & Kjaer	**Serial Number:**	2722891

Calibration Procedure

The sound level meter was allowed to stabilize for a suitable period, as described in the manufacturer's instruction manual, in laboratory conditions. The sound level meter was calibrated by carrying out the verification tests detailed in IEC 61672-3 (2006), Periodic tests, specification of sound level meters. Tolerances for verification procedures are specified in IEC 61672-1 (2003).

Calibration Standards

Description	Serial Number
National Instruments PXI-4461	19C91D2
Stanford Research DS360	123803
GRAS 42AA Pistonphone	227947
GRAS 46A0 Pressure Field Microphone	228216

The standards used in this calibration are traceable to NIST and/or other National Measurement Institutes (NMI's) that are signatories of the International Committee of Weights and Measures (CIPM) mutual recognition agreement (MRA).

Signed on behalf of Sonitus Systems:

CERTIFICATE OF CALIBRATION

ISSUED BY **Cirrus Research plc**

DATE OF ISSUE **12 August 2021** CERTIFICATE NUMBER **161301**

Cirrus Research plc
Acoustic House
Bridlington Road
Hunmanby
North Yorkshire
YO14 0PH
United Kingdom

Approved signatory
C.Scott
Electronically signed:

Sound Calibrator : IEC 60942:2003

Instrument information

Manufacturer: Cirrus Research plc **Notes:**

Model: CR:515

Serial number: 95716

Class: 1

Test summary

The sound calibrator detailed above has been calibrated to the published data as described in the operating manual and in the half-inch configuration. The procedures and techniques used are as described in IEC60942_2003 Annex B – Periodic Tests and three determinations of the sound pressure level, frequency and total distortion were made.

The sound pressure level was measured using a WS2F condenser microphone type MK:224 manufactured by Cirrus Research plc.

The results have been corrected to the reference pressure of 101.33 kPa using the manufacturer's data.

The manufacturer's product information indicates that this model of sound calibrator has been formally pattern approved to IEC60942_2003 Annex A to Class 1. This has been confirmed with the PhysikalischTechnische Bundesanstalt (PTB), Laboratoire National d'Essais (LNE) and APPLUS.

Notes:

CERTIFICATE OF CALIBRATION

Environmental conditions

The following conditions were recorded at the time of the test:

Pressure: 101.33 kPa
Temperature: 22.9 °C
Humidity: 45.7 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Acoustic Calibrator	Bruel and Kjaer	4231	2229486
Distortion Meter	Keithley	2015	0761605
Multimeter	Fluke	8845A	1293007

Results

	Expected	Sample 1	Sample 2	Sample 3	Average	Deviation	Tolerance	Uncertainty
Level (dB)	94.00	94.01	94.01	94.02	**94.01**	0.01	±0.40	0.11 dB
Distortion (%)	< 3.00	0.44	0.45	0.46	**0.45**	0.45	+3.00	0.13 %
Frequency (Hz)	1000.0	1000.3	1000.3	1000.3	**1000.3**	0.3	±10.0	0.1 Hz

The measured quantities or deviations (as applicable), extended by the expanded combined uncertainty of measurement, must not exceed the corresponding tolerance.

End of results