

Acoustic Survey Report



**Underground Combat
Zone (Airsoft Venue),
Kingsway Shopping
Centre, 2 Emlyn St,
Kingsway Centre,**

Client <i>Lee Higgins</i> <i>Underground Combat Zone</i> <i>Kingsway Shopping Centre</i> <i>2 Emlyn St</i> <i>Kingsway Centre</i> <i>Newport</i> <i>NP20 1HY</i>	Testing Organisation <i>Jigsaw Acoustics</i> <i>111 Gloucester Rd</i> <i>Bishopston</i> <i>Bristol</i> <i>BS7 8AT</i>
Tested Site <i>Underground Combat Zone</i> <i>(Airsoft Venue)</i> <i>Kingsway Shopping Centre</i> <i>2 Emlyn St</i> <i>Kingsway Centre</i> <i>Newport</i> <i>NP20 1HY</i>	
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1.0 Introduction

Jigsaw Acoustics were appointed by Lee Higgins to conduct Sound Insulation Testing at a CQB (Close Quarters Battle/Combat) Airsoft Venue on the lower ground level of the Kingsway Shopping Centre in Newport.

This report presents the outline basis of the site tests and provides the test results in relation to the airborne and impact sound insulation of the floors.

The sound transmission tests were carried out on the 7th December 2024 by Andrew Regan. Airborne and Impact sound tests were carried out on the floor between the Airsoft venue and shops/communal areas in the Kingsway Shopping Centre.

This report presents the methodology and findings of the airborne and impact sound transmission tests and makes comparisons to known guidance. Section 4.0 towards the end of the report provides the test results, a summary of which is displayed in Section 4.7.

The purpose of this report is to:

- a) Assess known guidance and criteria to use in the assessment of the sound generated by the airsoft grenade
- b) Test existing floors and walls between the airsoft venue and the shopping centre
- c) Assess the test results against relevant criteria
- d) Evaluate the impact of the airsoft venue on the general amenity (Defined in Section 2) of the shopping centre

About the Venue

The airsoft venue is located on the lower ground level of the Kingsway Shopping Centre and due to open from 8am-10pm 7 days a week. In comparison, the shopping centre is open from 6am-6pm Monday-Saturday and 10am-5pm on Sundays and Bank Holidays. The venue is planning to have between 80 & 100 airsoft players during a game.

Section 3.6 displays the area covered by the airsoft venue with a red outline.

2.0 Relevant Planning Conditions

Newport Council issued a (Conditional) Permission for Development under Planning application reference 24/0644 - Change of Use from Use Class A1 (Retail) to Use Classes A1, A2, A3, B1, D1 AND D2, facilitating Retails, Assemble and Leisure, Hospitality, Food and Drink, Financial and Professional Services.

The planning permission has been provided with the following conditions that are relevant to the acoustic survey and advice within this report:

“4. Prior to the conversion of any part of the site to a use falling within Use Class A3 or D2, as defined by the Town and Country Planning (Use Classes Order 1987 (as amended) (or any Order revoking or re-enacting that Order), details of the scheme including anticipated noise levels and a scheme for sound insulation works shall be submitted to and approved in writing by the Local Planning Authority. These uses shall operate in accordance with the approved hours.

Reason: To ensure that the amenities of occupiers of other premises in the vicinity are protected in accordance with Policy GP2 of the Newport City Council Local Development Plan.” (notes on GP2 below)

This report limits itself to addressing solely the internal noise control and acoustic aspects as specified above.

Notes:

General Policies		Commentary	Recommendation
GP2	General Amenity	Functioning effectively.	Carry forward with minimal changes.

Amenity:

“The dictionary definition of amenity is the “pleasantness or attractiveness of a place”. Therefore, in planning terms, as used in the National Planning Policy Framework, “amenity” is often used to refer to the quality or character of an area and elements that contribute to the overall enjoyment of an area.” (Planning Aid, 2024)

General amenity in a shopping centre

The Kingsway Centre is a publicly accessible space that could be affected by unwanted sound. There is a mix of commercial businesses from Café to fashion and mobility shops that have different requirements with regard to sound. For example, a fashion shop playing music may not hear or being affected by other loud sounds. Quantifying the effects can be achieved through a review of known guidance.

2.0 Relevant Criteria and Guidance

The acoustic survey has been conducted using the following guidance and criteria.

2.1 Planning Policy Wales

Planning Policy Wales sets out the noise policy for Wales. Although, the documents do not contain noise level criteria, descriptions are provided, which may be transposed to numerical noise levels for site-specific situations, using the methods contained within British Standards and other guidance documents.

2.2 Noise and Soundscape Plan for Wales 2023-2028

From the guidance listed in Annex E the following have been selected as the most relevant: BS 4142:2014+A1:2019; BS8233:2014 & Building Bulletin 93 Acoustic design of schools: performance standards. It is important to note that the reference is made to noise from commercial to residential not commercial to commercial, as is the case in the Kingsway Centre.

2.3 Guidance from NPSE and PPG-N

Perception	Examples of Outcomes	Increasing Effect	Level Action
Not present	No Effect	No Observed Effect	No specific measures required
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Effect	No specific measures required
Lowest Observed Adverse Effect Level (LOAEL)			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed adverse effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level (SOAEL)			
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting back to sleep. Diminished due to change in acoustic character of the area. Of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

Table 2.1: Summary of guidance in NPSE and PPG-N

2.4 BS 4142:2014+A1:2019

Margin by which the rating level of the specific sound source exceeds the background sound level	Likely effect
A difference of around +10 dB or more	Likely to be an indication of a significant adverse impact, depending on the context.
A difference of around +5 dB	Likely to be an indication of an adverse impact, depending on the context.
The rating level does not exceed the background sound level	This is an indication of the specific sound source having a low impact, depending on the context.

Table 2.2: Assessment of the impacts, BS4142:2014 (BSI, 2014)

BS4142 is not appropriate as an assessment method for this report as it is not intended to be applied to the assessment of indoor sound levels or low frequency noise. However, the above criteria could be used as a general guidance on the impact of the sound source on the general amenity. Annex C in BS4142 was used to assess whether the sound measured is tonal, it is shown in Appendix A-3 for reference. No tone was found for the grenade noise in the venue and through the floor.

2.5 BS 8233:2014

Section 7.5 of BS8233 provides details on internal sound insulation:

“In addition to controlling exterior noise and internal services noise, sound from adjacent spaces can affect the intended use, depending on the noise activity, noise sensitivity and privacy requirement. A matrix may be used to determine the sound insulation requirement of separating partitions once the noise activity, noise sensitivity and privacy requirements for each room and space are established (see 7.2). An example matrix, which can be adapted according to the specific building use, is given in Table 3 (shown below). Each room may be both a source and a receiving room. Where adjacent rooms have different uses, the worst-case sound insulation should be specified.”

Privacy requirement	Activity noise of source room	Noise sensitivity of receiving rooms		
		Low sensitivity	Medium sensitivity	Sensitive
Confidential	Very High	47	52	57 ^{A)}
	High	47	47	52
	Typical	47	47	47
	Low	42	42	47
Moderate	Very High	47	52	57 ^{A)}
	High	37	42	47
	Typical	37	37	42
	Low	No rating	No rating	37
Not private	Very High	47	52	57 ^{A)}
	High	37	42	47
	Typical	No rating	37	42
	Low	No rating	No rating	37

NOTE Background noise can also influence privacy. See also 7.7.6.3.

^{A)} $D_{nT,w}$ 55 dB or greater is difficult to obtain on site and room adjacencies requiring these levels should be avoided wherever practical.

Table 2.3: Table 3 - Example on-site sound insulation matrix (dB $D_{nT,w}$), BS8233:2014 (BSI, 2019)

The guidance in Table 2.3 suggests that when adjacent rooms have different uses, the worst-case airborne sound insulation for walls and floors of 57dB $D_{nT,w}$ should be specified. Reference is made to hotel impact of 62 dB $L'_{nT,w}$, however this cannot be applied to noise between commercial units. BS8233 also states “For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments.” This could be applied to the general amenity of the shopping centre.

Activity	Location	Design range dB $L_{Aeq, T}$
Speech or telephone communications	Department store Cafeteria, canteen, kitchen	50-55
	Concourse Corridor, circulation space	45-55
Study and work requiring concentration	Library, gallery, museum	40-50
	Staff/meeting room, training room	35-45
	Executive office	35-40
Listening	Place of worship, counselling, meditation, relaxation	30-35

Table 2.4: Table 6 Typical noise levels in non-domestic buildings, BS8233: 2014 (BSI, 2019)

The most appropriate sound levels for the Kingsway Shopping Centre are 50-55 dB $L_{Aeq, T}$ in the shops and 45-55 dB on the concourse.

2.5.1 Noise Rating (NR) Curves

Noise Rating as stated in BS8233 are a “graphical method for rating a noise by comparing the noise spectrum with a family of noise rating curves” Although these are not designed for noise through a floor, the rating may give an indication of performance in comparison to known levels shown below:

Max NR Level	Application
NR 25	Concert halls, broadcasting and recording studios, churches
NR 30	Private dwellings, hospitals, theatres, cinemas, conference rooms
NR 35	Libraries, museums, court rooms, schools, hospitals operating theatres and wards, flats, hotels, executive offices
NR 40	Halls, corridors, cloakrooms, restaurants, night clubs, offices, shops
NR 45	Department stores, supermarkets, canteens, general offices
NR 50	Typing pools, offices with business machines
NR 60	Light engineering works
NR 70	Foundries, heavy engineering works

Table 2.5: Maximum recommended Noise Rating (NR) Levels

2.6 BB93 Acoustic Design of Schools: Performance Standards (2015)

BB93 (Building Bulletin 93) is a document published by the Department for Education in England stating the minimum performance standards for acoustics in schools. The document was designed to ensure that school buildings provide adequate acoustic conditions, conducive to effective teaching and learning.

BB93 performance standards for walls and floors are displayed in Tables 2.6, 2.7, 2.8 and 2.9 below:

Table 1 of BB93 specifies room classification for the purpose of sound insulation in the following BB93 Table 3a. Where a type of room is not listed, the nearest approximation should be used. Where a room is used for more than one purpose, the most onerous condition should be used.

Type of room	Room classification for the purpose of airborne sound insulation in Tables 3a and 3b	
	Activity noise (Source room)	Noise tolerance (Receiving room)
Secondary music classroom ¹ Small and large practice/group room ¹ Performance/recital room ¹	Very high	Low
Ensemble room ¹ Recording studio ¹	Very high	Low
Administration and ancillary spaces: Kitchen Office, medical room, staff room Corridor, stairwell, coats and locker area Changing area Toilet	High Low Average High Average	High Medium High High High

¹ Music rooms – the levels of sound insulation between some music rooms may not be sufficient for particularly noisy activities and timetabling/management will need to be considered. Wherever possible music accommodation should make use of buffer spaces such as stores to increase the levels of sound insulation between rooms and to isolate rooms where very noisy activities such as drum practice will take place. If timetabling/management or isolation is not possible the levels of sound insulation should be increased. For further guidance on the design of music accommodation see 'Music Accommodation in Secondary Schools: a Design Guide', DfE, NBS/RIBA, 2010 Ref.12 and 'Acoustics of Schools: a design guide' Ref.1

Table 2.6: BB93 Table 1: noise activity and sensitivity levels (Department for Education, 2015)

Minimum $D_{nT,w}$ (dB)		Activity noise in source room (see Table 1)			
		Low	Average	High	Very high
Noise tolerance in receiving room (see Table 1)	High	Not applicable	30	35	45
	Medium	30	40	45	45
	Low	35	40	50	50

Table 2.7: BB93 Table 3b: refurbishment performance standards for airborne sound insulation between spaces (Department for Education, 2015)

Type of room (receiving room)	Maximum impact sound pressure level $L'_{nT,w}$ dB	
	New build	Refurbishment
Music: Secondary music room Small and large practice/group room Ensemble room Performance/recital room Recording studio Control room - for recording Control room – not for recording	55	60

Table 2.8: BB93 Table 5: performance standards for impact sound insulation of floors (Department for Education, 2015)

Room/Area	Source Noise	Receive Noise Tolerance
Airsoft Venue	Very High	Very High
Kingsway walkway	High	Average
Shop	Average	Low
Cafe	Average	Average

Table 2.9: Noise Tolerance Classification

The above classification indicates that the strictest BB93 Airborne wall and floor $D_{nT,w}$ that can be applied is 50dB. It is often advised to apply a 5dB increase to this, particularly when low frequency sound is a consideration. This equates to 55dB. The strictest impact floor $L'_{nT,w}$ that can be applied is 60dB for a refurbishment.

2.7 Approved Document E & C_{tr} Spectrum adaption

Approved Document E (Building Regulation Part E) was designed to address sound insulation requirements for “dwelling-houses and flats” and for “rooms for residential purposes”. The material change of use airborne ($D_{nT,w} + C_{tr}$ 43dB) and impact ($L'_{nT,w}$ 64dB) criteria are not strict enough for the loud sound generated by the airsoft grenade. (The new build airborne is $D_{nT,w} + C_{tr}$ 45dB and impact $L'_{nT,w}$ of 62dB). However, the C_{tr} spectrum adaption can be utilized for the assessment of sound transfer between the airsoft venue and the shopping centre.

C_{tr} – The correction to a sound insulation quantity (such as $D_{nT,w}$) to take account of a specific sound spectrum. See BS EN ISO 717-1: 1997 (Appendix A-4) Cross referencing this table with the sound level spectra calculation table also in Appendix A-4, it is evident that the spectrum adaption used in the overall calculation of $D_{nT,w} + C_{tr}$ is appropriate for use in this report. Approved Document E utilizes BS EN ISO 140-4:1998 - Part 4 & BS EN ISO 717-2:1997.

2.8 BS EN ISO 140-4:1998 - Part 4: Field measurements of airborne sound insulation between rooms

1. General

In low-frequency bands (lower than about 400Hz in general and especially lower than 100 Hz), no diffuse-field conditions in the test rooms can be expected, especially when room volumes of only 50 m³ or even less are considered. The general requirement that the room dimensions should be at least one wavelength cannot be fulfilled for the lowest frequency bands. The small number of room modes in the frequency bands are the cause of standing wave structures that are found in the whole room space.

The excitation of the room modes is highly dependent on the source locations. The sound reduction index depends strongly on which room modes are excited. Even if the repeatability is reduced at low frequencies, the reproducibility may be very poor.

In order to reduce the spread of the measured results, additional effort is necessary with regard to the excitation and sampling of the sound field in the rooms and the special requirements that the rooms have to meet.

In rooms with small volumes and unfavourable dimensions, it is not always possible to obtain reliable results of low frequency measurements. At least one room dimension should be of one wavelength and another of at least half a wavelength of the lowest band centre frequency, and there should be the space to position the source and the microphones according to the requirements.

2. Minimum distances

A strong sound pressure level increase should be measured towards the room boundaries from a distance of about a quarter of a wavelength. The minimum separating distances have to be increased linearly, being doubled for measurements in the 50Hz band. For the distance between the microphone positions and the room boundaries, about 1.2m should be the ultimate limit. This is also valid for the distances between microphone positions and the surface of the separating element.

3. Sampling of the sound field

In order to obtain a reliable average of the sound pressure levels in the room volume, the number of microphone positions should be increased. The microphone positions should be spread uniformly throughout the allowable volume of the room. If a moving microphone is used, it should sample all parts of the allowable volume uniformly. At very low frequencies where the room dimensions tend to be in the range of half a wavelength, extremely low sound pressure values are found in the centre part of the room. Therefore, suitable microphone positions should also be found outside this area.

4. Loudspeaker positions

The lack of diffusivity in small rooms at low-frequency measurements can be partly compensated by exciting different sound fields one after the other and averaging the results. Therefore, the number of loudspeaker positions has to be increased; the minimum number should be three.

5. Averaging time

Due to the smaller absolute filter bandwidth and low modal overlap, the averaging times should be increased to no less than 15 seconds for measurements in the 50Hz band (about three times compared to the requirements for measurements at 100Hz). When using a moving microphone, the averaging time should not be less than 60 seconds.

6. Reverberation time

At very low frequencies, test rooms with hard surfaces tend to have long reverberation times. This should be avoided in order to reduce the dominance of single room modes by improving the modal overlap. The absorption in the room should be well distributed (BSI, 1999, pp.15 & 16).

2.9 BS EN ISO 717-2:1997 - Part 7: Field measurements of impact sound insulation between rooms

Generation of the sound field

The impact sound shall be generated by the tapping machine (see clause 4). The tapping machine shall be placed in at least four different positions randomly distributed on the floor under test. The distance of the tapping machine from the edges of the floor shall be at least 0,5 m. In the case of anisotropic floor constructions (with ribs, beams, etc.), more positions may be necessary. The hammer connecting line should be orientated at 45° to the direction of the beams or ribs.

The impact sound pressure levels may reveal a time dependency after the tapping is started. In such a case the measurements should not begin until the noise level has become steady. If stable conditions are not reached after 5 min, then the measurements should be carried out over a well-defined measurement period. The measurement period shall be reported.

When floors with soft coverings are under test, the standard tapping machine shall fulfil the special requirements given in Annex A. Advice regarding the mounting of the standard tapping machine on soft floor coverings is given also in Annex A.

Please see Section 2.8 for details on sampling and reverberation time. Please see test methodology for more detail on the measurement procedure.

3.0 Test Methodology

The test methodology has been adapted using guidance provided in Section 2.0 of this report. This includes: BB93, BS EN ISO 140-4:1998 and BS EN ISO 140-7:1998.

3.1 Equipment Calibration

Equipment Description / Manufacturer / Type	Serial Number	Date of calibration	Calibration Certification Number
Acoustic Analyzer, Norsonic, Nor140	140529	26/07/2023	U44943, U44944
Microphone, Norsonic, 1225	142460	26/07/2023	44942
Microphone Pre-Amp, NTi, MA220	15278	26/07/2023	44492
Calibrator, Norsonic, 1251	33122	29/10/2024	U49110
Tapping Machine, Delta OHM, HD2040	19024581	29/06/2023	06228/1
Pink Noise Generator, NTi, Minrator MR Pro	G2P-RAJSG-G1	-	-
Dodecahedron Speaker, Delta OHM HD2050	24017096	-	-
Amplifier, Crown XLS 1502	-	-	-

Table 3.1: Details of Equipment and Calibration Information for Norsonic Nor140 and Sound Testing Equipment

Equipment Description / Manufacturer / Type	Serial Number	Date of calibration	Calibration Certification Number
Acoustic Analyzer, NTi, XL2-TA	A2A-13841-E0	19/07/2023	06228/4, 06228/5
Microphone Capsule, NTi, MC230A	A16699	29/06/2023	06228/3
Microphone Pre-Amp, NTi, MA220	8144	29/06/2023	06228/3
Calibrator, Delta OHM, HD2020	19014406	18/06/2024	06772/1

Table 3.2: Details of Equipment and Calibration Information for NTi XL2

3.2 Airborne Sound Transmission Test

Measurements of standardised level difference (D_{nT}) were carried out in accordance with BS EN ISO 140-4:1998. The ratings of airborne sound insulation were calculated in accordance with British Standard EN ISO 717-1:1997.

Level measurements in the Source & Receive Room (L1 & L2)

A steady spectrum of Pink Noise was generated in the source room using an active loudspeaker which was placed in the corner of the room at least 0.5m away from any reflective surface.

The level of sound was measured in both the source room and receive room, sampling as much of the room as possible. The sound level meter was always kept 0.7m away from any reflective surface as to not artificially increase or decrease noise levels into the microphone.

The measurements were taken at one third octave band intervals from 100 to 3150 Hertz using an average time of 30 seconds for each of the 2 sound source positions. The measurements in each room were arithmetically averaged.

Background Measurements in Receive Room (B2)

Where noise levels were measured in the receive room, the background noise level was also measured with the speaker turned off. This is to ensure the background noise level did not influence the result. The background noise level is measured over a time period that accurately reflects the background noise measurement at the time of the test. This is normally between 6 & 30 seconds and can vary between the first and second background measurements.

Any receive room noise measurements that are within 6dB of the background measurements are corrected by logarithmically averaging the difference to correct the receive room measurement. The correction is applied up to 10dB, where a maximum correction of 1.6dB is applied. Any background noise level greater than 10dB over the L2 measurement will appear to reduce the sound insulation at that frequency.

Reverberation Time Measurements (T2, or T20)

A minimum of 6 reverberation time measurements were also taken in the receive room using a minimum of 3 microphone positions at each of 2 loud speaker positions in accordance with BS EN ISO 354:2003 (also complies with BS EN 20354) to accurately define the level of influence the diffuse field has on the microphone, ensuring that an increase in soft or hard surfaces does not impact the overall test result.

3.3 Impact Sound Transmission Test

Measurements of standardised level difference (L_{nT}) were carried out in accordance with BS EN ISO 140-7:1998. The ratings of impact sound insulation were calculated in accordance with British Standard EN ISO 717-2:1997.

Level measurements in the Receive Room (L2)

Level measurements were acquired in the receive room using a tapping machine, which has a set of 5 steel hammers to produce impact noise on the separating floor.

The tapping machine is always orientated at 45 degrees to the main floor axis.

The noise level was measured in the receive room at 2 microphone positions at one third octave band intervals from 100 to 3150 Hertz using an average time of at least 6 seconds for each of 4 tapping machine positions, creating 8 individual measurement readings.

Measurements were always taken at least 0.7m away from any reflective or absorptive surfaces.

Background Measurements in Receive Room (B2)

Where noise levels were measured in the receive room, the background noise level was also measured with the tapping machine turned off. This is to ensure the background noise level did not influence the result. The background noise level is measured over a time period that accurately reflects the background noise measurement at the time of the test. This is normally between 6 & 30 seconds and can vary between the first and second background measurements.

Any receive room noise measurements that are within 6dB of the background measurements are corrected by logarithmically averaging the difference to correct the receive room measurement. The correction is applied up to 10dB, where a maximum correction of 1.6dB is applied. Any background noise level greater than 10dB over the L2 measurement will appear to reduce the sound insulation at that frequency.

Reverberation Time Measurements (T2, or T20)

A minimum of 6 reverberation time measurements were also taken in the receive room using a minimum of 3 microphone positions at each of 2 loud speaker positions in accordance with BS EN ISO 354:2003 (also complies with BS EN 20354) to accurately define the level of influence the diffuse field has on the microphone, ensuring that an increase in soft or hard surfaces does not impact the overall test result. These measurements are often the same readings as the airborne test when measured in the same group of tests.

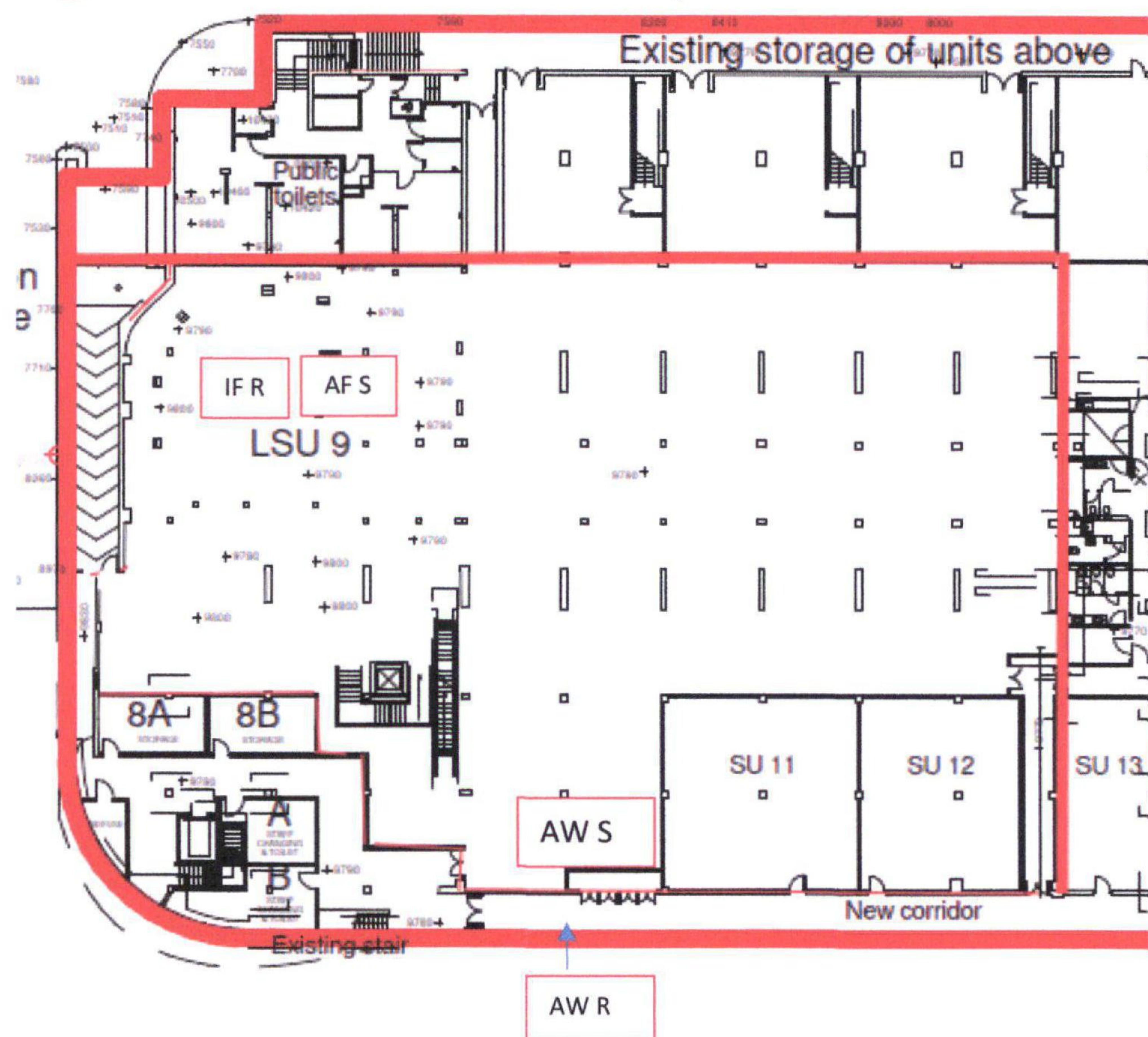
3.4 Deviations

If any deviation from the testing method was necessary, details of the deviation are indicated on each individual test certificate (Appendix A-1 and A-2). Some deviations, such as background noise levels, are often an unavoidable part of testing in an active building.

3.5 Construction of Separating Element

Floor Description: Concrete slab, tiled floor finish (specific constructions are shown on the individual test certificates).

3.6 Measurement Locations





KEY:

- AF S = Airborne Floor Source Position
- AF R = Airborne Floor Receive Position
- IF S = Impact Floor Source Position
- IF R = Impact Floor Receive Position
- AW S = Airborne Wall Source Position
- AW R = Airborne Wall Receive Position
- BN1 = Background Noise Measurement Position 1

4.0 Test Results

4.1 Floor Tests

The BB93 minimum required airborne level of $D_{nT,w}$ is 55dB and the maximum required impact level of $L'_{nT,w}$ is 55dB. The BS8233 minimum required airborne level of $D_{nT,w}$ is 57dB (there is no relevant impact level). Noise tolerance classifications for the airborne sound tests are displayed in Section 2.5 & 2.6 of this report.

The results are as follows:

Source Room		Receive Room		Measured			BB93 Criteria $D_{nT,w} / L'_{nT,w}$ (dB)	BS8233 Criteria $D_{nT,w}$ (dB)	Test Report No.
Details	Volume (m ³)	Details	Volume (m ³)	$D_{nT,w}$ (dB)	$D_{nT,w} + C_{tr}$ (dB)	$L'_{nT,w}$ (dB)			
Airsoft Venue (Nr raised area)	8000	Kingsway walkway (Nr Boswells Café)	9000	62	59	-	55	57	JA0581/A
Kingsway walkway (Nr Boswells Café)	9000	Airsoft Venue (Nr raised area)	8000	-	-	53	60	-	JA0581/B

Table 4.1: Floor Test Results (LZeq) (volumes are estimated and are not included in the calculation)

Using the LZeq, the airborne floor performance $D_{nT,w}$ rating exceeds the BB93 criteria by 7dB and the BS8233 criteria by 5dB. If the low frequency adaption C_{tr} were included, the rating exceeds the criteria by 4dB and 2dB respectively. The impact floor performance $L'_{nT,w}$ rating exceeds the BB93 criteria by 7dB.

The worst-case sound measurement frequency data that can be transferred into the calculation for $D_{nT,w} + C_{tr}$ is the LZFmax. Below are the results using this measurement parameter.

Source Room		Receive Room		Measured			BB93 Criteria $D_{nT,w} / L'_{nT,w}$ (dB)	BS8233 Criteria $D_{nT,w}$ (dB)	Test Report No.
Details	Volume (m ³)	Details	Volume (m ³)	$D_{nT,w}$ (dB)	$D_{nT,w} + C_{tr}$ (dB)	$L'_{nT,w}$ (dB)			
Airsoft Venue (Nr raised area)	8000	Kingsway walkway (Nr Boswells Café)	9000	61	58	-	55	57	JA0581/C
Kingsway walkway (Nr Boswells Café)	9000	Airsoft Venue (Nr raised area)	8000	-	-	56	60	-	JA0581/D

Table 4.2: Floor Test Results (LZFmax) (volumes are estimated and are not included in the calculation)

Using the LZFmax, the airborne floor performance $D_{nT,w}$ rating exceeds the BB93 criteria by 6dB and the BS8233 criteria by 4dB. If the low frequency adaption C_{tr} were included, the rating exceeds the criteria by 3dB and 1dB respectively. The impact floor performance $L'_{nT,w}$ rating exceeds the BB93 criteria by 4dB.

Graphical representations of the above results are displayed in Appendix A-1 and A-2 of this report.

4.2 Wall Test

The minimum required level of $D_{nT,w} + C_{tr}$ is 57dB. The results are as follows:

Source Room		Receive Room		Measured			BB93 Criteria $D_{nT,w} / L'_{nT,w}$ (dB)	BS8233 Criteria $D_{nT,w}$ (dB)	Test Report No.
Details	Volume (m ³)	Details	Volume (m ³)	$D_{nT,w}$ (dB)	$D_{nT,w} + C_{tr}$ (dB)	$L'_{nT,w}$ (dB)			
Airsoft Venue Storage area	35	Communal Corridor	140	63	57	-	55	57	JA0581/E

Table 4.3: Wall Test Results (LZeq) (volumes are estimated and are not included in the calculation)

Using the LZeq, the airborne floor performance $D_{nT,w}$ rating exceeds the BB93 criteria by 8dB and the BS8233 criteria by 6dB. If the low frequency adaption C_{tr} were included, the rating exceeds the BB93 criteria by 2dB and meets the BS8233 criteria.

The worst-case sound measurement frequency data that can be transferred into the calculation for $D_{nT,w} + C_{tr}$ is the LZFmax. Below are the results using this measurement parameter.

Source Room		Receive Room		Measured			BB93 Criteria $D_{nT,w} / L'_{nT,w}$ (dB)	BS8233 Criteria $D_{nT,w}$ (dB)	Test Report No.
Details	Volume (m ³)	Details	Volume (m ³)	$D_{nT,w}$ (dB)	$D_{nT,w} + C_{tr}$ (dB)	$L'_{nT,w}$ (dB)			
Airsoft Venue Storage area	35	Communal Corridor	140	62	58	-	55	57	JA0581/F

Table 4.4: Wall Test Results (LZFmax) (volumes are estimated and are not included in the calculation)

Using the LZeq, the airborne floor performance $D_{nT,w}$ rating exceeds the BB93 criteria by 7dB and the BS8233 criteria by 5dB. If the low frequency adaption C_{tr} were included, the rating exceeds the BB93 criteria by 3dB and the BS8233 criteria by 1dB.

Graphical representations of the above results are displayed in Appendix A-1 and A-2 of this report.

4.3 Background Noise Measurements

A background noise measurement was recorded in the Kingsway Shopping Centre (Location BN1 in Section 3.6) between 13:35 and 13:50 on 18.12.24. The LAeq, 15mins for this time period was recorded as 64.6dB(A). The full table of results for the time period is shown below.

Date	Start Time	Stop Time	LAeq	LCPKmax	LAFmax	LAFmin	LCFmax	LCImax	LAeq	LZeq
[DD-MM-YY]	[hh:mm:ss]	[hh:mm:ss]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
18/12/2024	13:35:46	13:50:46	64.6	92.6	80.4	55.8	80	82.2	68.4	69.1

Table 4.5: Kingsway Shopping Centre – 15min Background Noise Measurements (Static) 18.12.24.

Date	Start Time	Stop Time	LAeq	LCPKmax	LAFmax	LAFmin	LCFmax	LCImax	LAeq	LZeq
[DD-MM-YY]	[hh:mm:ss]	[hh:mm:ss]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
18/12/2024	13:54:16	14:03:17	63.1	97.2	75.9	54.7	77.6	80.9	67.3	69.9

Table 4.6: Kingsway Shopping Centre - Background Noise Measurements (Walking) 18.12.24.

Subjective Assessment notes

General people talking, noise from Boswells Cafe, some banging from a nearby shop, footfall on reflective floor, EE sales counter in open area, 13:44 cleaner pushing a wheelie bin walked past. The café was fairly busy as it was lunchtime.

Background compared with Measured Sound Pressure Levels

Data Measurement	Grenade 2.5m LG Floor LAeq	Grenade at Gr Floor Level LAeq	Static Background LA90	Grenade SPL compared with Static LA90	Moving Background LA90	Grenade SPL compared with Moving LA90
SPL dB(A)	109.7	43.5	60	-16.5	58	-14.5

Table 4.7: Assessment of measured airsoft game noise during shopping centre opening hours

The calculations in the above table have not been made exactly using BS4142 as the criteria of this report does not meet those in the document. For example, the LA90 and specific level. However, as stated earlier in the report there were no tonal aspects found through the frequency range.

BS4142: 2014

When comparing the Grenade SPL measurement average LAeq with the background LA90 the reductions are both in excess of 14.5dBA. This is an indication of the specific sound source having a low impact, depending on the context. The context of the survey is important to consider as the guidance in BS4142 is meant to be used for sound levels at residential properties not for commercial to commercial.

BS8233:2019

To assess quieter periods the most appropriate sound levels for the Kingsway Shopping Centre are 50-55 dB LAeq,T in the shops and 45-55 dB on the concourse as shown in Section 2.5. At 43.5dB the grenade is 1.5dB below the lowest parameter from BS8233 (45dB).

4.5 Noise Rating Curve

The Sound Pressure Level LZeq of the Grenade measured through the ground floor in the atrium of the shopping centre was used to plot the noise rating curve. The Noise Rating for this area is 41, which below the recommended maximum for shopping centres and only just over that of a nightclub (40). Appendix A-5 shows the full NR calculation.

Max NR Level	Application
NR 25	Concert halls, broadcasting and recording studios, churches
NR 30	Private dwellings, hospitals, theatres, cinemas, conference rooms
NR 35	Libraries, museums, court rooms, schools, hospitals operating theatres and wards, flats, hotels, executive offices
NR 40	Halls, corridors, cloakrooms, restaurants, night clubs, offices, shops
NR 45	Department stores, supermarkets, canteens, general offices
NR 50	Typing pools, offices with business machines
NR 60	Light engineering works
NR 70	Foundries, heavy engineering works

Table 4.8: Maximum recommended Noise Rating (NR) Levels

4.7 Summary and Analysis of Test Results

Below is a summary table of the results using measurement parameters from Section 4.1 - 4.5.

Criteria	Criteria Level	Measurement Parameter	Measured/Calculated Level	Met or Exceeded (+) Criteria
BB93 $D_{nT,w}$ (dB)	55	LZFmax	58	+ 3dB
BB93 $L'_{nT,w}$ (dB)	60	LZFmax	56	+ 4dB
BS8233 $D_{nT,w}$ (dB)	57	LZFmax	61	+ 4dB
BS8233 Background (dB)	45	LAeq	43.5	+ 1.5dB
NR Curve	45	LZeq	41	+ 4dB

Table 4.9: Summary of Criteria and Results of Sound Insulation Tests and Background Noise Measurement

Lowest Observed Adverse Effect Level (LOAEL) & Significant Observed Adverse Effect Level (SOAEL)

Perception	Examples of Outcomes	Increasing Effect	Level Action
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Effect	No specific measures required
Lowest Observed Adverse Effect Level (LOAEL)			

BS4142 (Guideline background level only)

Margin by which the rating level of the specific sound source exceeds the background sound level	Likely effect
The rating level does not exceed the background sound level	This is an indication of the specific sound source having a low impact, depending on the context.

Assessing the results above the criteria are either all met or exceeded. This would suggest that the general amenity in the shopping centre will not be impeded by the presence of the airsoft venue on the lower ground floor of the Kingsway Shopping Centre.

The context in which the assessment has been conducted is that it was carried out within a shopping centre, with a mix of various retail outlets, shop music, café noise and person generated noise in the walkway areas. The assessment has been designed for this unique situation and the results reflect the data collected as accurately as possible.

Additional considerations

During an airsoft game there is also likely to be a certain amount of person generated noise. Gathering data for this element would be very difficult as the venue has not yet opened and there isn't any historic data from other venues that can be applied. Data from indoor hockey games (involving shouting) show that spectator noise can range between 85 dB and 100 dB (WHO, 2015) another study showed that the average sound level is around 90 dB (Adams, 2016). Both these studies show that the levels of person generated noise would be below that of the grenade as therefore it still considered the worst-case sound source in the airsoft venue.

5.0 Limitations

Test results for each test are authorised by the Testing Engineer. The report has been prepared for, and is for the sole use of, the 'Client' indicated at the beginning of this report. Results from the testing are from in-situ tests conducted on specific wall and floor constructions as stated in Section 3.5, and at the location stated in Section 1.0 of this report. The results are inclusive of flanking and workmanship, and therefore, cannot be transferred to any other construction or building type. Floor coverings and furnishings were present during testing due to the timing of the tests, which will have affected the results. Therefore, performance ratings should be used as a guide only.

The report may not be presented other than in full electronic or printed form, without the written permission of the Testing Organisation. We disclaim any responsibility to the Client and others in respect of any matters outside the scope of the above. The report is provided for the sole use of the named Client and is confidential to them and their professional advisors. No responsibility is accepted to any third party and no liability is accepted outside the scope of this report.

6.0 Appendices

6.1 Appendix A-1: Airborne Test Results

Standardized level difference measured in accordance with BS EN ISO 140-4 Field Measurements of Airborne Sound Insulation between Rooms			
Site:	Underground Combat Zone	Date of Test:	07.12.24.
Test Type:	Airborne Floor (LZeq)	Client:	Lee Higgins
Source Room:	Airsoft Venue (Nr raised area)	Receive Room:	Kingsway walkway (Nr Boswells Café)
Source Room Volume (m³):	8000	Receive Room Volume (m³):	9000
Area of separating element (m²):	2000		
Separating Element Construction:	Concrete slab, tiled floor finish		

Frequency <i>f</i> Hz	<i>D_{nT}</i> dB
50	
63	
80	
100	45.6 ≥
125	51.5 ≥
160	55.4 ≥
200	55.5 ≥
250	56.2 ≥
315	58.4 ≥
400	59.8 ≥
500	59.6 ≥
630	60.2 ≥
800	61.8 ≥
1000	61.6 ≥
1250	62.5 ≥
1600	57.4 ≥
2000	63.8 ≥
2500	62.7 ≥
3150	63.3 ≥
4000	
5000	

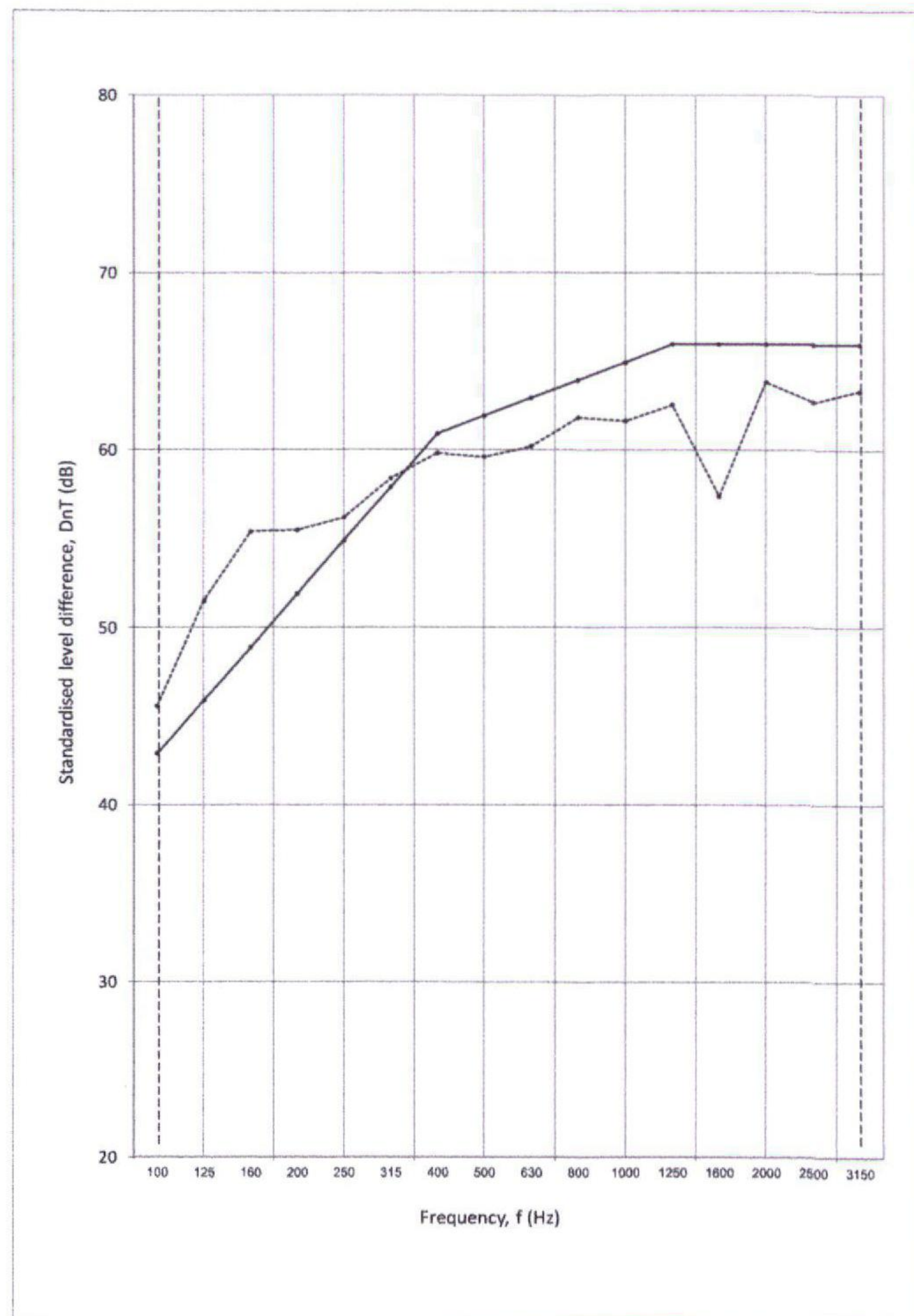
≥ = A correction of 1.3dB has been applied in this frequency band as the difference between the background noise level and the receive level is less than or equal to 6dB.

* = The receive level has been logarithmically adjusted for background noise in this frequency band as the difference between the background noise level and the receive level is between 6 and 10dB.

----- *D_{nT,w}*
 ————— Reference Value Curve (ISO 717-1)

Rating in accordance with ISO 717-1			
<i>D_{nT,w}</i>	62		dB
<i>C_{tr}</i>	-3		dB
<i>D_{nT,w} + C_{tr}</i>	59		dB

Evaluation based on field measurement results obtained
in one-third-octave bands by an engineering method.



Test Report No.	JA0581/A	Date of Report	27.12.24.
Name of Test Institute	Jigsaw Acoustics	Signature	A Regan
Deviations	Floor finishes present, Source - timber internal partitions (not to ceiling) Receive - Shop and café furniture		

Standardized level difference measured in accordance with BS EN ISO 140-4 Field Measurements of Airborne Sound Insulation between Rooms			
Site:	Underground Combat Zone	Date of Test:	07.12.24.
Test Type:	Airborne Floor (LZFmax)	Client:	Lee Higgins
Source Room:	Airsoft Venue (Nr raised area)	Receive Room:	Kingsway walkway (Nr Boswells Café)
Source Room Volume (m ³):	8000	Receive Room Volume (m ³):	9000
Area of separating element (m ²):	2000		
Separating Element Construction:	Concrete slab, tiled floor finish		

Frequency <i>f</i> Hz	D _{nT} dB
50	
63	
80	
100	46.2 ≥
125	50.8 *
160	56.3 *
200	57.5 *
250	57.5 *
315	59.0 *
400	60.1 *
500	60.9 ≥
630	61.3 ≥
800	62.9 ≥
1000	61.4 ≥
1250	63.6 ≥
1600	52.8 *
2000	63.9 ≥
2500	59.2 *
3150	59.8 *
4000	
5000	

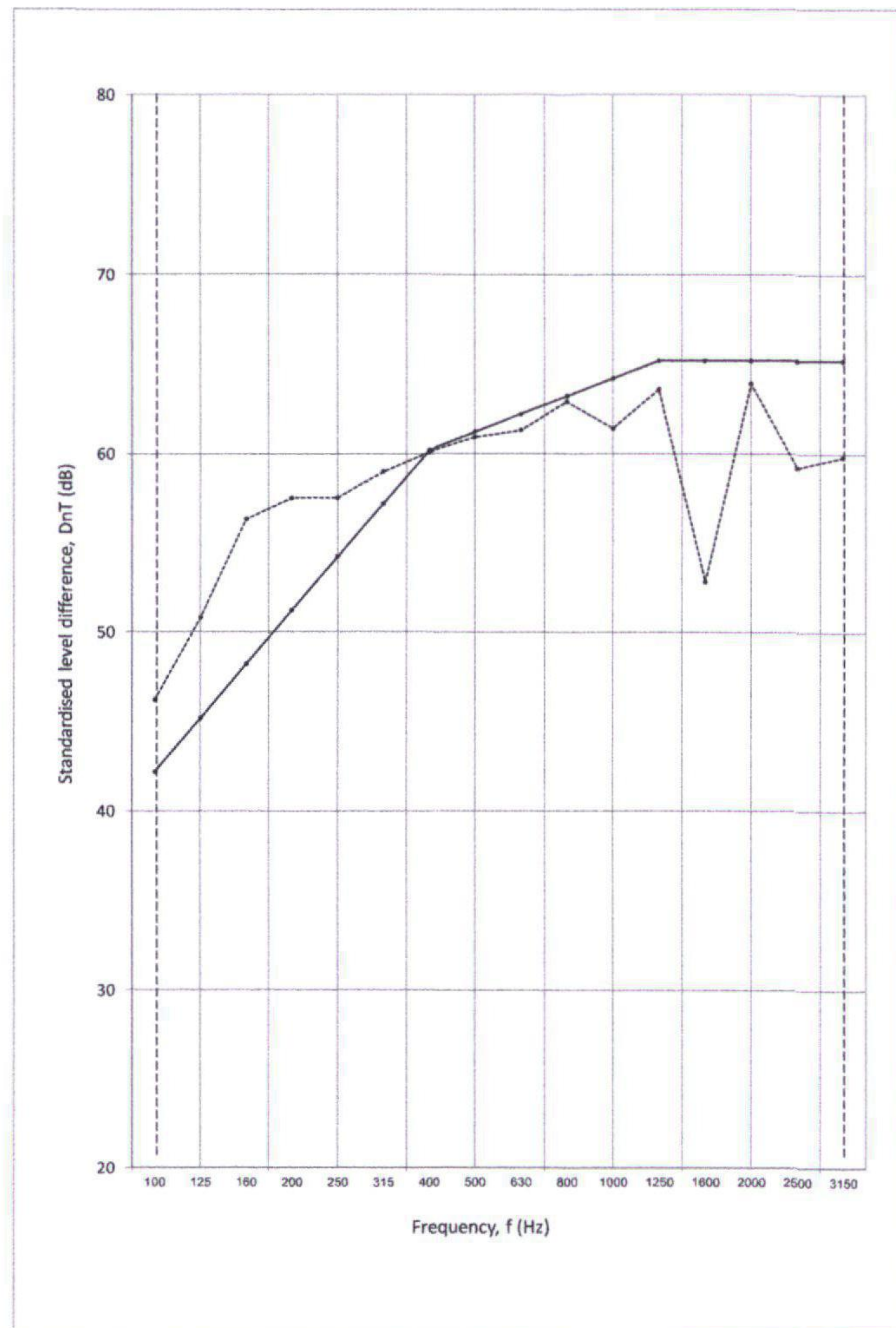
≥ = A correction of 1.3dB has been applied in this frequency band as the difference between the background noise level and the receive level is less than or equal to 6dB.

* = The receive level has been logarithmically adjusted for background noise in this frequency band as the difference between the background noise level and the receive level is between 6 and 10dB.

----- D_{nT,w}
——— Reference Value Curve (ISO 717-1)

Rating in accordance with ISO 717-1			
D _{nT,w}	61		dB
C _{tr}	-3		dB
D _{nT,w} + C _{tr}	58		dB

Evaluation based on field measurement results obtained in one-third-octave bands by an engineering method.



Test Report No. JA0581/C Date of Report 27.12.24.
Name of Test Institute Jigsaw Acoustics Signature A Regan
Deviations Floor finishes present, Source - timber internal partitions (not to ceiling)
Receive - Shop and café furniture

Standardized level difference measured in accordance with BS EN ISO 140-4 Field Measurements of Airborne Sound Insulation between Rooms			
Site:	Underground Combat Zone	Date of Test:	07.12.24.
Test Type:	Airborne Wall (LZeq)	Client:	Lee Higgins
Source Room:	Airsoft Storage Area	Receive Room:	Communal Corridor
Source Room Volume (m ³):	35	Receive Room Volume (m ³):	140
Area of separating element (m ²):	20		
Separating Element Construction:	Masonry wall		

Frequency <i>f</i> Hz	D _{nT} dB
50	
63	
80	
100	44.1
125	53.3
160	48.0
200	48.4
250	52.2
315	54.0
400	56.7
500	60.4
630	64.8
800	64.5
1000	63.3
1250	65.0 ±
1600	66.1 *
2000	66.1
2500	66.8 *
3150	67.7
4000	
5000	

± = A correction of 1.3dB has been applied in this frequency band as the difference between the background noise level and the receive level is less than or equal to 6dB.

* = The receive level has been logarithmically adjusted for background noise in this frequency band as the difference between the background noise level and the receive level is between 6 and 10dB.

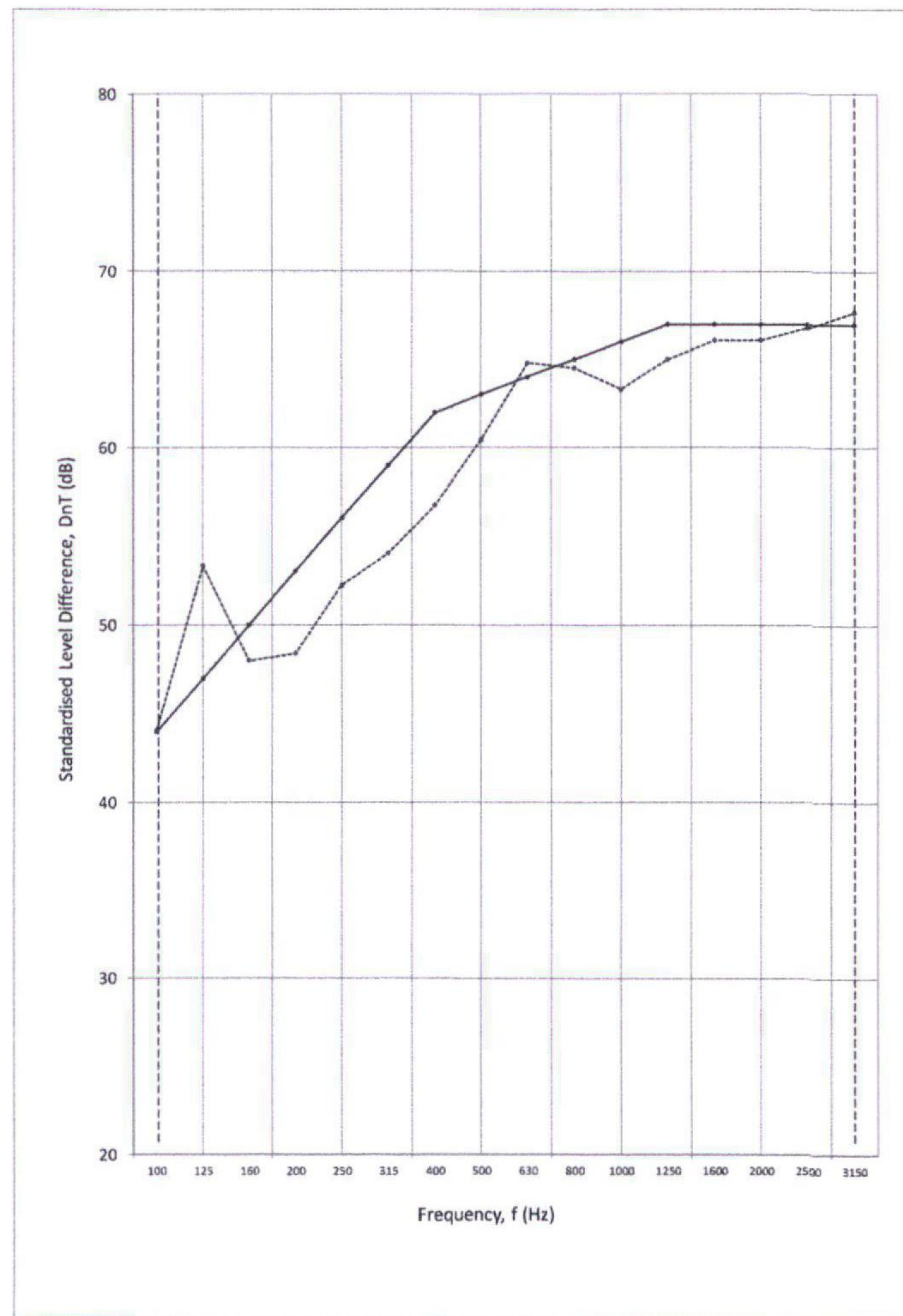
----- D_{nT,w}
——— Reference Value Curve (ISO 717-1)

Rating in accordance with ISO 717-1		
D _{nT,w}	63	dB
C _{tr}	-6	dB
D _{nT,w} + C _{tr}	57	dB

Evaluation based on field measurement results obtained in one-third-octave bands by an engineering method.

Test Report No. JA0581/E
Name of Test Institute Jigsaw Acoustics
Deviations

Date of Report 27.12.24.
Signature A Regan



Standardized level difference measured in accordance with BS EN ISO 140-4 Field Measurements of Airborne Sound Insulation between Rooms			
Site:	Underground Combat Zone	Date of Test:	07.12.24.
Test Type:	Airborne Wall (LZFmax)	Client:	Lee Higgins
Source Room:	Airsoft Storage Area	Receive Room:	Communal Corridor
Source Room Volume (m ³):	35	Receive Room Volume (m ³):	140
Area of separating element (m ²):	20		
Separating Element Construction:	Masonry wall		

Frequency f Hz	D _{nT} dB
50	
63	
80	
100	42.7
125	54.4
160	50.0
200	49.9
250	55.0
315	55.2
400	59.0
500	61.4
630	65.7
800	63.4
1000	62.6
1250	60.9 *
1600	62.1
2000	63.7
2500	61.1
3150	61.1
4000	
5000	

≤ = A correction of 1.3dB has been applied in this frequency band as the difference between the background noise level and the receive level is less than or equal to 6dB.

* = The receive level has been logarithmically adjusted for background noise in this frequency band as the difference between the background noise level and the receive level is between 6 and 10dB.

----- D_{nT,w}
——— Reference Value Curve (ISO 717-1)

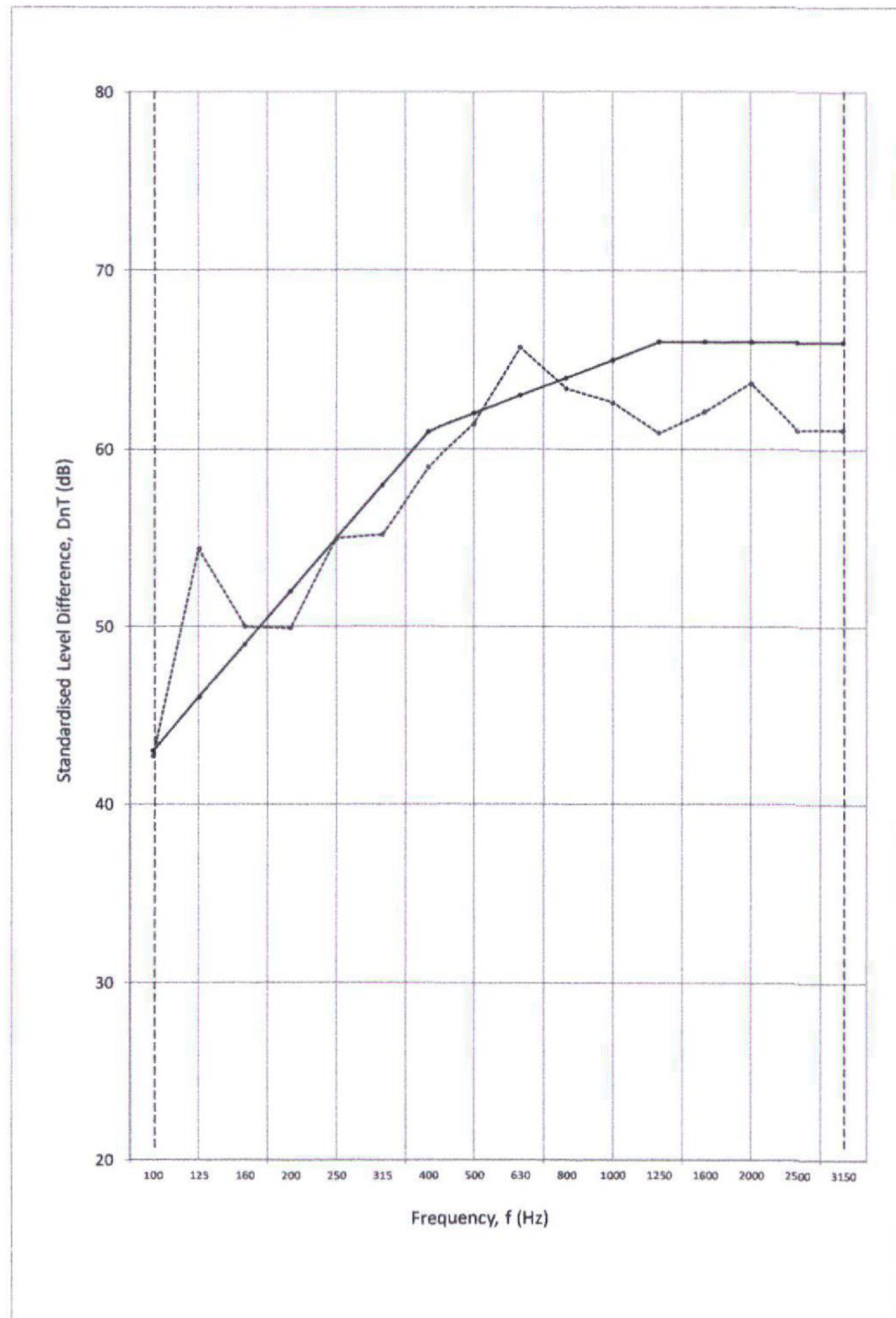
Rating in accordance with ISO 717-1

D _{nT,w}	62	dB
C _{tr}	-4	dB
D _{nT,w} + C _{tr}	58	dB

Evaluation based on field measurement results obtained in one-third-octave bands by an engineering method.

Test Report No. JA0581/F
Name of Test Institute Jigsaw Acoustics

Date of Report 27.12.24.
Signature A Regan



6.2 Appendix A-2: Impact Test Results

Standardized level difference measured in accordance with BS EN ISO 140-7			
Field Measurements of Impact Sound Insulation of Floors			
Site:	Underground Combat Zone	Date of Test:	07.12.24.
Test Type:	Impact Floor (L _{Zeq})	Client:	Lee Higgins
Source Room:	Kingsway walkway (Nr Boswells Café)	Receive Room:	Airsoft Venue (Nr raised area)
Source Room Volume (m ³):	9000	Receive Room Volume (m ³):	8000
Area of separating element (m ²):	2000		
Separating Element Construction:	Concrete slab, tiled floor finish		

Frequency <i>f</i> Hz	L' _{nT} dB
50	
63	
80	
100	36.3
125	39.7
160	39.4
200	40.6
250	41.6
315	41.6
400	42.5
500	44.0
630	44.2
800	44.7
1000	45.9
1250	46.5
1600	47.2
2000	48.0
2500	47.9
3150	46.3
4000	
5000	

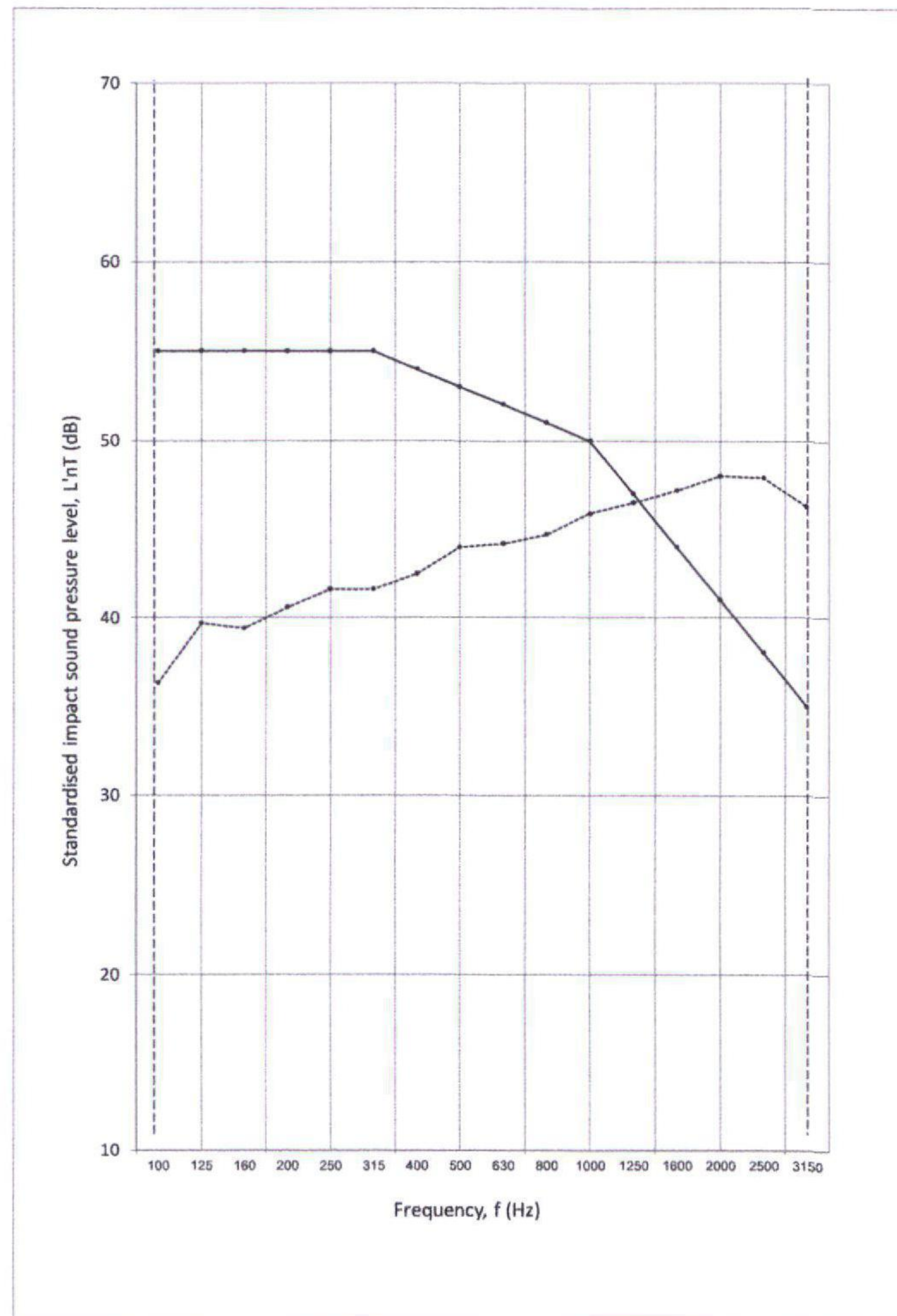
≤ = A correction of 1.3dB has been applied in this frequency band as the difference between the background noise level and the receive level is less than or equal to 6dB.

* = The receive level has been logarithmically adjusted for background noise in this frequency band as the difference between the background noise level and the receive level is between 6 and 10dB.

----- L'_{nT,w}
 ————— Reference Value Curve (ISO 717-2)

Rating in accordance with ISO 717-2
L' _{nT,w} 53 dB

Evaluation based on field measurement results obtained in one-third-octave bands by an engineering method.



Test Report No. JA0581/B

Date of Report 27.12.24.

Name of Test Institute Jigsaw Acoustics

Signature A Regan

Deviations Floor finishes present, Receive - timber internal partitions (not to ceiling)
 Source - Shop and café furniture

Standardized level difference measured in accordance with BS EN ISO 140-7 Field Measurements of Impact Sound Insulation of Floors			
Site:	Underground Combat Zone	Date of Test:	07.12.24.
Test Type:	Impact Floor (LZFmax)	Client:	Lee Higgins
Source Room:	Kingsway walkway (Nr Boswells Café)	Receive Room:	Airsoft Venue (Nr raised area)
Source Room Volume (m ³):	9000	Receive Room Volume (m ³):	8000
Area of separating element (m ²):	2000		
Separating Element Construction:	Concrete slab, tiled floor finish		

Frequency <i>f</i> Hz	<i>L'</i> _{nT} dB
50	
63	
80	
100	41.7
125	44.2
160	43.8
200	44.4
250	45.7
315	44.9
400	46.2
500	47.5
630	47.6
800	47.3
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1250	48.6
1600	49.8
2000	50.6
2500	50.4
3150	48.5
4000	
5000	

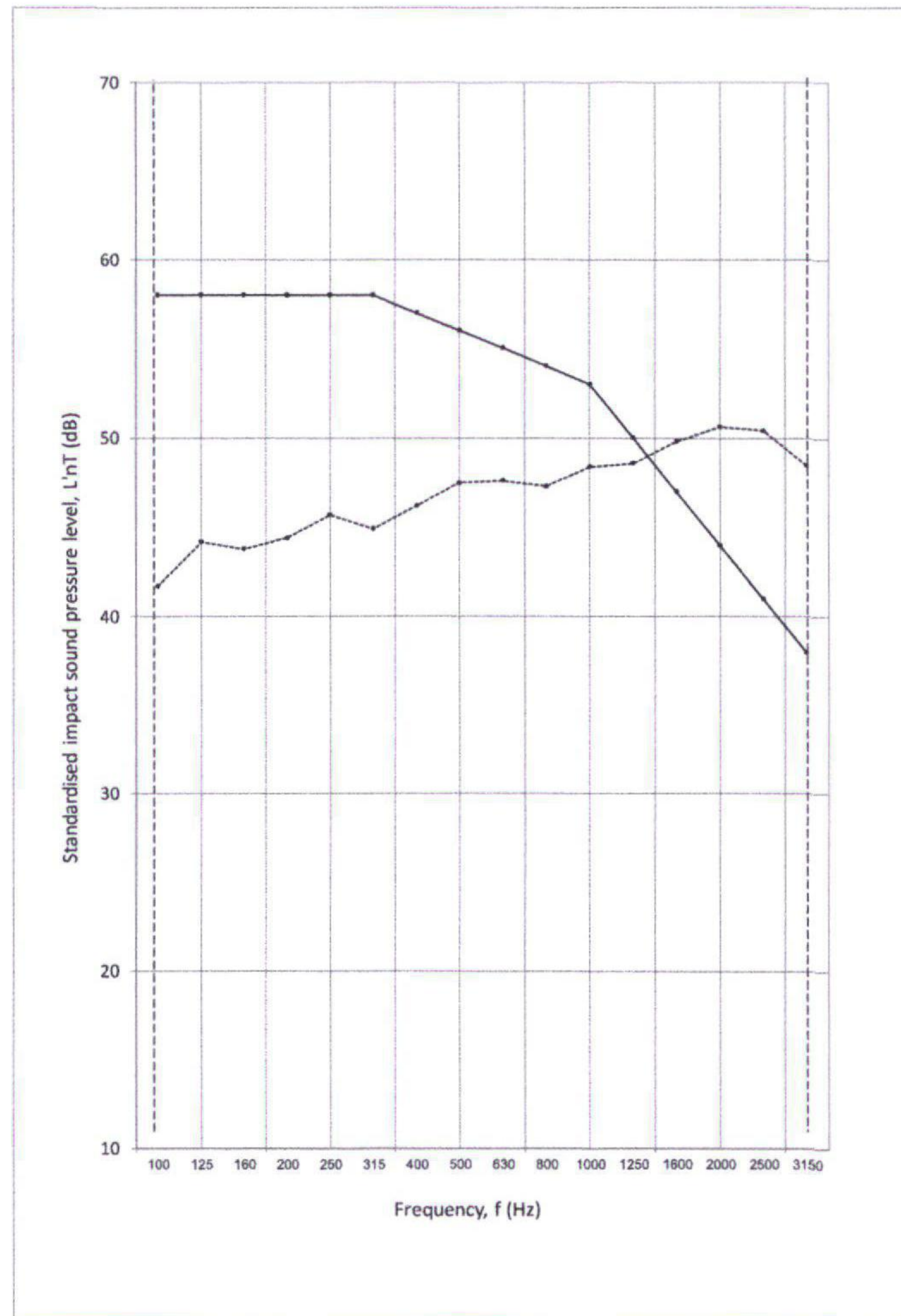
≤ = A correction of 1.3dB has been applied in this frequency band as the difference between the background noise level and the receive level is less than or equal to 6dB.

* = The receive level has been logarithmically adjusted for background noise in this frequency band as the difference between the background noise level and the receive level is between 6 and 10dB.

----- *L'*_{nT,w}
 ——— Reference Value Curve (ISO 717-2)

Rating in accordance with ISO 717-2
<i>L'</i> _{nT,w} 56 dB

Evaluation based on field measurement results obtained in one-third-octave bands by an engineering method.



Test Report No. JA0581/D

Date of Report 27.12.24.

Name of Test Institute Jigsaw Acoustics

Signature A Regan

Deviations Floor finishes present, Receive - timber internal partitions (not to ceiling)
 Source - Shop and café furniture

6.3 Appendix A-3: BS4142:2019 Annex C (normative)

Objective method for assessing the audibility of tones in sound: One-third octave method

The test for the presence of a prominent, discrete-frequency spectral component (tone) typically compares the $L_{Zeq,T}$ sound pressure level averaged over the time when the tone is present in a one-third-octave band with the time-average linear sound pressure levels in the adjacent one-third-octave bands. For a prominent, discrete tone to be identified as present, the time-averaged sound pressure level in the one-third-octave band of interest is required to exceed the time-averaged sound pressure levels of both adjacent one-third-octave bands by some constant level difference.

The level differences between adjacent one-third-octave bands that identify a tone are:

- 15 dB in the low-frequency one-third-octave bands (25 Hz to 125 Hz);
- 8 dB in the middle-frequency one-third-octave bands (160 Hz to 400 Hz);
- and
- 5 dB in the high-frequency one-third-octave bands (500 Hz to 10 000 Hz).

6.4 Appendix A-4: C_{tr} Spectrum adaption Sound Level Spectra (To calculate the adaptation terms for enlarged frequency range)

Table A.1 – Relevant spectrum adaption term for different types of noise source BS EN ISO 717-1: 1997

Type of noise source	Relevant spectrum adaptation term
Living activities (talking, music, radio, TV) Children playing Railway traffic at medium and high speed ^a Highway road traffic at >80 km/h ^a Jet aircraft, short distance Factories emitting mainly medium- and high-frequency noise	C (spectrum No. 1)
Urban road traffic Railway traffic at low speeds ^a Aircraft, propeller driven Jet aircraft, large distance Disco music Factories emitting mainly low and medium frequency noise	C_{tr} (spectrum No. 2)
^a In several European countries, calculation models for highway road traffic noise and railway noise exist, which define octave band levels; these could be used for comparison with spectra Nos. 1 and 2.	

Table B.1 – sound level spectra to calculate the adaption terms for enlarged frequency range

Frequency	Sound levels, L_{ij} , dB					
Hz	Spectrum No.1 to calculate				Spectrum No.2 to calculate C_{tr} for any frequency range	
	$C_{50-3150}$		$C_{50-5000}$ and $C_{100-5000}$			
	One-third octave	Octave	One-third octave	Octave	One-third octave	Octave
50	-40		-41		-25	
63	-36	-31	-37	-32	-23	-18
80	-33		-34		-21	
100	-29		-30		-20	
125	-26	-21	-27	-22	-20	-14
160	-23		-24		-18	
200	-21		-22		-16	
250	-19	-14	-20	-15	-15	-10
315	-17		-18		-14	
400	-15		-16		-13	
500	-13	-8	-14	-9	-12	-7
630	-12		-13		-11	
800	-11		-12		-9	
1 000	-10	-5	-11	-6	-8	-4
1 250	-9		-10		-9	
NOTE All levels are A weighted and the overall spectrum level is normalized to 0 dB.						

Frequency	Sound levels, L_{ij} , dB					
Hz	Spectrum No.1 to calculate				Spectrum No.2 to calculate C_{tr} for any frequency range	
	$C_{50-3150}$		$C_{50-5000}$ and $C_{100-5000}$			
	One-third octave	Octave	One-third octave	Octave	One-third octave	Octave
1 600	-9		-10		-10	
2 000	-9	-4	-10	-5	-11	-6
2 500	-9		-10		-13	
3 150			-10		-15	
4 000	-9		-10	-5	-16	-11
5 000			-10		-18	
NOTE All levels are A weighted and the overall spectrum level is normalized to 0 dB.						

6.5 Appendix A-5: NR Curve Calculation - Kingsway Shopping Centre

Frequency (Hz)	a	b	Grenade (dB)	NR
31.5	55.4	0.7	47	-12.3
63	35.4	0.8	49	17.1
125	22.0	0.9	48	30.2
250	12.0	0.9	49	39.4
500	4.2	1.0	42	38.4
1000	0.0	1.0	38	38.4
2000	-3.5	1.0	38	40.8
4000	-6.1	1.0	27	32.2
8000	-8.0	1.0	16	23.5

NR = 41

7.0 References

British Standards Institution (2019). "British Standard 4142:2014+2019 "Methods for rating and assessing industrial and commercial sound". London: BSI Group

British Standards Institution (2014). "British Standard 8233:2014 Code of practice for sound insulation and noise reduction for buildings". London: BSI Group

British Standards Institution (2009). "BS EN ISO 140-4:1998 Acoustics - Measurement of sound insulation in buildings and of building elements - Part 4: Field measurements of airborne sound insulation between rooms". London: BSI Group

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