

Airsoft Weapons Acoustic Survey Report



**Underground Combat
Zone (Airsoft Venue),
Kingsway Shopping
Centre, 2 Emlyn St,
Kingsway Centre, Newport
NP20 1HY**

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1.0 Introduction

Jigsaw Acoustics were appointed by Lee Higgins to conduct an Airsoft Weapons Acoustic Survey in conjunction with Test Report JA0515B at 63 Hampden Road, Newport and a CQB (Close Quarters Battle/Combat) Airsoft Venue on the lower ground floor of the Kingsway Centre in Newport.

This report presents the outline methodology of the acoustic measurements and provides the test results in relation to the sound generated by the airsoft weapons. An approximation has also been made for the noise break-in of the worst-case weapon to the walkway and shops on the ground floor in Section 5.1.

The purpose of this report is to:

- a) Ascertain the sound levels generated by the weapons without the effect of internal building characteristics e.g. reverberation and compare with indoor measurements
- b) Test existing methodology and data measurements for suitability in airsoft
- c) Determine which are the most accurate measurement parameters to use for the sound insulation test report JA0581B
- d) Determine worst-case sound measurement from the airsoft grenade and gun

The report has been tailored to fit these requirements.

The acoustic measurements were taken on the 7th December 2024 by Andrew Regan. Section 5.0 towards the end of the report provides the test results, a summary of which is displayed in Section 5.3.

Definitions for key terms in this report are provided in Section 7.

2.0 Airsoft Legislation and Guidance

In the UK, airsoft weapon legislation is covered by The Firearms Act 1968. The Home Office Guide on Firearms Licensing Law (Nov 2022) & Handbook of defence ranges safety (JSP 403) are also used for reference in this report. There is no reference made to noise limits in these documents, however they do contain useful information on definitions and measurement parameters.

Although air grenades do not generate any flash effect like 'Flashbangs' (which are classified as fireworks in the UK) BS EN 14035 - Fireworks & BS 7114 - Fireworks have been used for measurement indices and methodology.

CQB (Close Quarters Battle) or CQC (Close Quarters Combat) CQB are terms originally used by trained police or military units. These are special methods used by trained police or military units. It means fighting in confined spaces. It is one of the two main types of airsoft play and it is considered the faster paced type of play.

Typically, players of a CQB game will use around 3-4 magazines and play for between 5-30 minutes. The guns used in a close quarters battle are also different than an outdoor field style game. Instead of trying to increase range and accuracy, the main goal of a CQB gun is to be fast, lightweight, compact, and easy to manoeuvre to increase the users speed and efficiency.

2.1 The Firearms Act 1968

Definition of an 'airsoft' gun

2.4 An 'airsoft' gun as defined in section 57A of the 1968 Act is not regarded as a firearm for the purposes of that Act. Section 57A defines an airsoft gun as a barrelled weapon of any description which is designed to discharge only a small plastic missile (whether or not it is also capable of discharging any other kind of missile) and is not capable of discharging a missile of any kind above the permitted kinetic energy thresholds at the muzzle of the weapon (see below). A 'small plastic missile' is defined in section 57A(3) as a missile that:

- a) is made wholly or partly from plastics;
- b) is spherical, and
- c) does not exceed 8 millimetres in diameter.

Section 57A(4) sets the maximum permitted kinetic energy levels for airsoft guns at:

- a) 1.3 joules if the weapon is capable of discharging two or more missiles successively without repeated pressure on the trigger, and
- b) 2.5 joules in any other case.

2.41 The Violent Crime Reduction Act 2006 (Realistic Imitation Firearms) Regulations 2007 (SI 2007/2606) provides two further defences which apply to an offence under section 36 of the 2006 Act. The first is a defence for making a realistic imitation firearm available for 'permitted activities', defined as "the acting out of military or law enforcement scenarios for the purposes of recreation" and primarily intended to cover those participating in airsoft skirmishing. It is a requirement under the regulations that third party liability insurance is held in connection with such activities. The second is a defence for display of realistic imitation firearms at a 'permitted event', defined as a commercial event at which firearms or realistic imitation firearms (or both) are offered for sale or displayed (i.e. arms fairs).

2.2 Violent Crimes Reduction Act (2006)

In 2006 the Violent Crimes Reduction Act made it an "offence for a person of any age to fire an air weapon beyond the boundary of premises. A defence is provided to cover the situation where the person shooting

has the consent of the occupier of the land over or into which he shoots.” (Crown copyright, 2007) Therefore, the weapons measurements had to be taken in the garden of the owners’ property and not in free-field conditions. All attempts were made to reduce the effects of reflective surfaces as noted in Section 4: Methodology.

2.3 British Standards BS 7114

- Category F3 - Fireworks which present a medium hazard, which are intended for outdoor use in large open areas and whose noise level is not harmful to human health (i.e. display fireworks for open areas such as fields).

All consumer fireworks are limited to 120dB (A,imp) which corresponds with the noise rating for the air grenade used (See section 3.2).

2.4 IEC-61672:2013

LAI dB - A-weighted impulse measurement dB(AI). Impulse (I) Time Weighting (as specified in IEC-61672:2013) is intended for the analysis of short impulses. In contrast to 'F' and 'S', the 'I' time weighting it is asymmetric, i.e. it adapts very steeply rising curve ($t = 35\text{ms}$), while it decays very slowly after a level drop (2.9 dB/s).

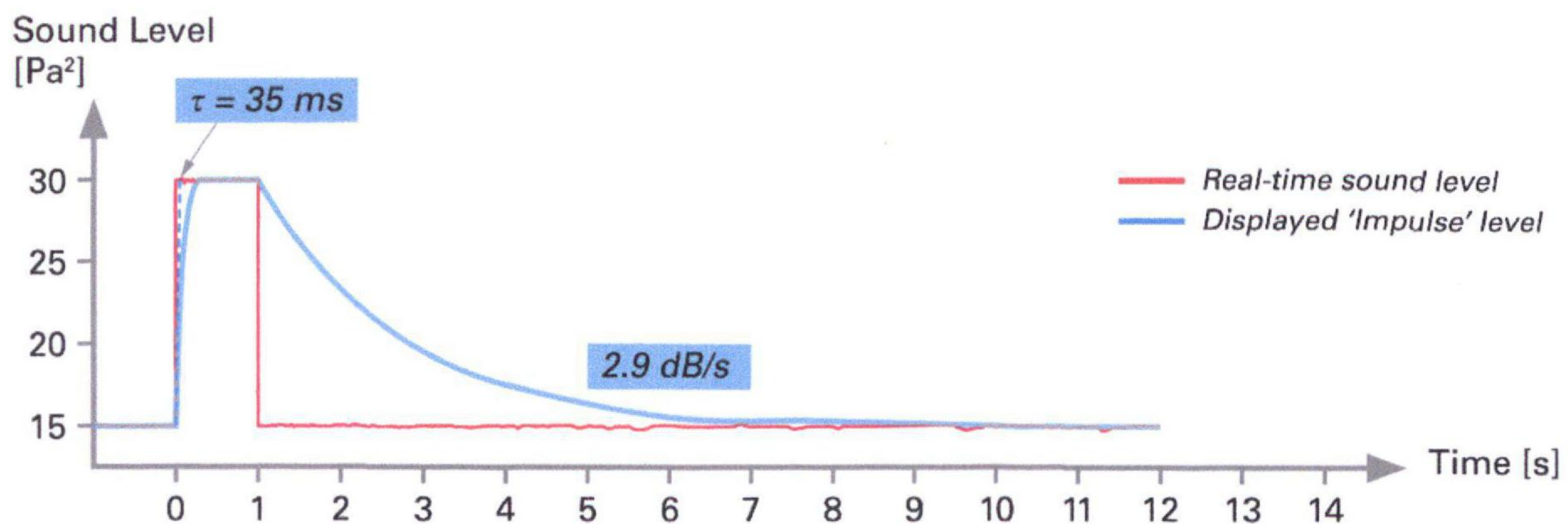


Figure 2.1: Impulse Sound Measurement Chart (NTi, 2020)

2.5 BS EN 14035

BS EN 14035 is a series of documents that are tailored for the varying types of fireworks that exist. Therefore, a representative sample has been taken to decide upon measurement technique and other parameters. When tested in accordance with 9.3, a category 3 mine or rocket shall produce a maximum A-weighted impulse sound pressure level (LAI_{max}) of not higher than 120 dB(AI) at a horizontal distance of 15m from the testing point and at a height of 1m above the ground. (BSI, 2004)

The distances used during testing had to be reduced because of restrictions at the test site.

3.0 Airsoft Weapons tested

Lee Higgy provided weapons on the day of the test that will be the only ones available to players at the Airsoft venue. Details are provided below:

3.1 Gun

ASG CZ Scorpion Evo 3 ATEK A.C.E AEG Rifle

- Mechanical gearbox gun. The gearbox is where the loudest sound is generated from, therefore measurements will be concentrated in this area.
- The airgun has an option to run automatically (in rapid fire mode), however Lee Higgy confirmed the weapons will only ever be used in single shot mode during Airsoft games. The measurements were therefore taken using only single shot mode.
- Specification
 - Length: 425-625mm/16.7inch
 - Width :58mm
 - Barrel Length: 208mm/8.2inch
 - Mag. Capacity: 375 Rounds
 - Battery: 19364
 - Standard mag: 18394
 - Hop up type: Adjustable
 - Velocity: 105ms/350fps
 - Weight: 2350gr/5.2lb
 - Energy: 1,05 joule

3.2 Grenade

Tectonic Innovations Quake 8-way Impact Grenade Qu8ke with .209 primer rounds

- Similar air grenades are acoustically rated at 120dB (no specific acoustic data was found for this model)

4.0 Test Methodology

The following section outlines the method used for conducting the tests.

4.1 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
Calibrator, Norsonic, 1251	33122	29/10/2024	U49110

Table 4.1: Details of Equipment and Calibration Information for Norsonic Nor140

Equipment Description / Manufacturer / Type	Serial Number	Date of calibration	Calibration Certification Number
Acoustic Analyzer, NTi, XL2 TA	A2A-13841-E0	12/12/2024	U49492, U49493
Microphone Capsule, NTi, MC230A	A16699	11/12/2024	49491
Microphone Pre-Amp, NTi, MA220	8144	11/12/2024	49491
Calibrator, Delta OHM, HD2020	19014406	18/06/2024	06228/2

Table 4.2: Details of Equipment and Calibration Information for NTi XL2

Microphone calibration drift did not exceed 0.5dB during the measurements. Both measurement microphones are limited to 120dB.

4.2 Measurement Parameters

Measurements of LfFmax (LZFmax), LAFmax, LAImax, LLCFmax, LCImax, LCpeak were taken during testing. Time averaged measurements of LZeq, LAeq, LAI and LAeq were also recorded at the test site. LfFmax (LZFmax) will be used for Octave and Frequency Analysis

4.3 Background Sound Level Measurement

The sound level meter was situated at 2.5m from the source on a tripod approximately 1.5m from the ground and a measurement of the sound in the surrounding area was taken. The measurement was recorded as 49dB(A) LAeq, which is not deemed to be high enough to have affected the results.

Description of site:

Residential garden measuring approximately 8m x 15m with concrete slab flooring and 1.8m timber fencing.

4.4 Weapon Sound Measurements (Outdoor)

The Firearms Legislation Regulation (Section 2 of this report) was followed where possible. As this was a test specific to airsoft weaponry, the parameters were selected to suit conditions.

Method (Gun)

1. The gun operator stood on level ground approximately 1.5m from the nearest reflective surface.
2. The sound level meter was situated at 1m from the source on a tripod approximately 1.5m from the ground and approximately level with the gearbox of the gun.
3. The sound level meter operative began a measurement and then provided a signal to the gun operator to start firing the gun using a) single shot mode.
4. A 30 second sound measurement was recorded.
5. The process was repeated using b) single shot mode and a silencer & c) single shot mode and a tracer (illuminated) unit.

Method (Gun pellets striking various materials)

1. The gun operator stood on level ground approximately 1.5m from the nearest reflective surface.
2. The sound level meter was situated at 10cm from the impact zone of the pellet on a tripod.
3. The sound level meter operative began a measurement and then provided a signal to the gun operator (standing 1m from the impact material) to start firing the gun with a tracer unit on it (to aid in aiming in dark conditions) into a) concrete block.
4. A 30 second sound measurement was recorded.
5. Steps 1-4 were repeated for impact material b) Foam encased timber box.
6. Steps 1-5 were then repeated with the gun operator standing at 5m from the impact zone.

Method (Grenade)

1. The gun operator stood on level ground approximately 1.5m from the nearest reflective surface.
2. The sound level meter was situated at 1m from the operator on a tripod approximately 1.5m from the ground.
3. The sound level meter operative began a measurement and then provided a signal to the gun operator to drop the grenade on the ground.
4. A 30 second sound measurement was recorded.
5. The process was repeated for a 2.5m & 5m distance from the weapon.

4.5 Weapon Sound Measurements (Indoors)

Method (Grenade)

The method from the indoor sound measurement was followed as shown above in “Method (Grenade)”

4.6 Deviations

If any deviation from the testing method was necessary, details of the deviations are indicated on each individual result. Some deviations, such as background noise levels, are often an unavoidable part of testing as testing was carried out in a commercial business area. All efforts were taken to mitigate the effects of wind and background noise during the outdoor sound measurements.

5.0 Test Results

1 second measurement data is displayed as this is the worst-case scenario and the sound level measurements of both the gun and grenade are instantaneous. (all measurement data is available on request)

5.1 Weapon Sound Measurements

Gun and Grenade Test

The worst-case gun (with tracer unit) and grenade LZFmax frequency data recorded at 2.5m was used for the comparison graph below.

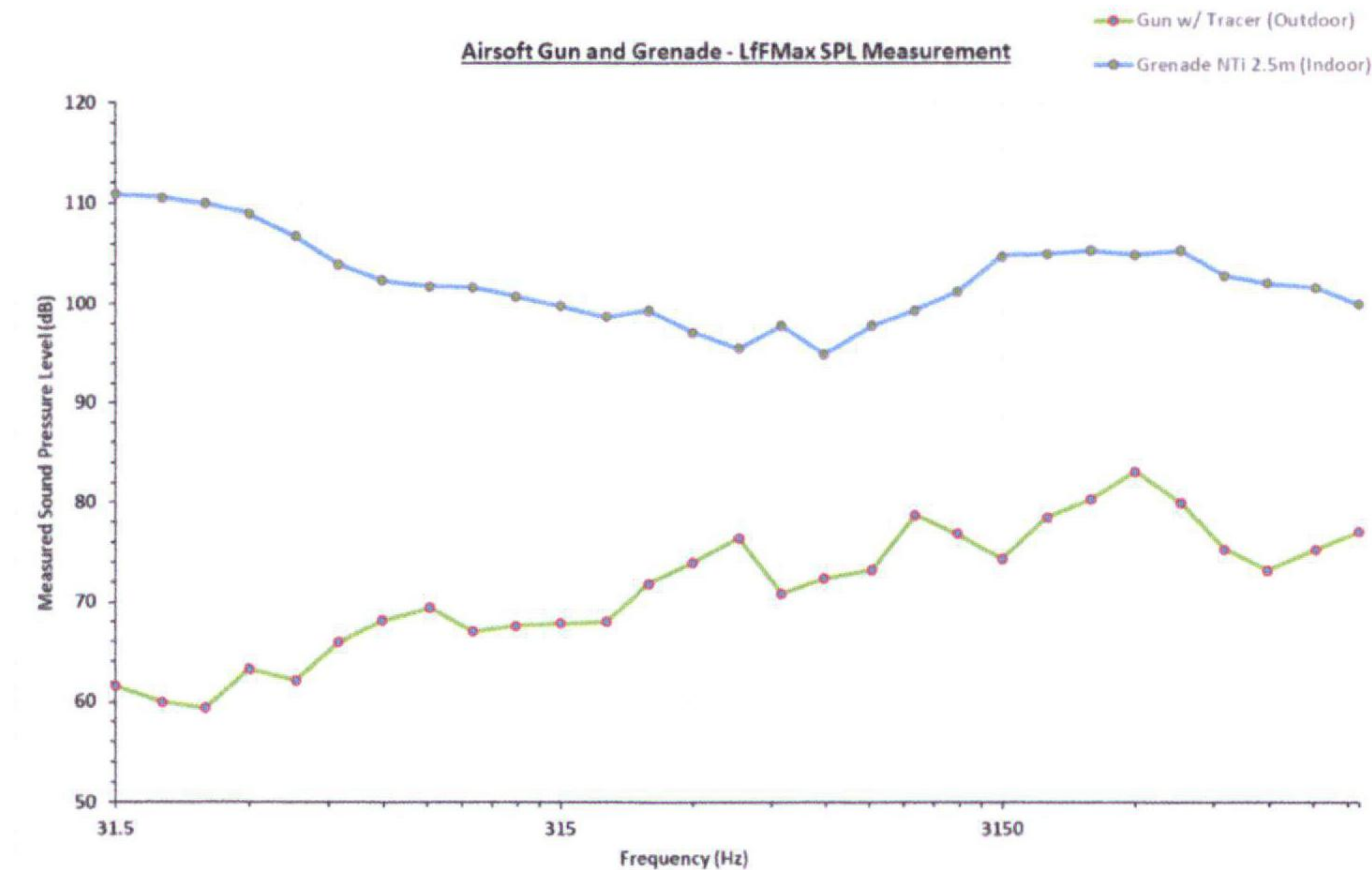


Figure 5.1: Sound measurement from the airsoft gun and grenade at 1m & 2.5m distance

The grenade is clearly the worst-case weapon during testing. The above chart displays the largest component of sound in the frequency range 31.5-315Hz with an LZFmax of 110.9dB at 31.5Hz. There is also a large component of sound between 3.15 & 8kHz.

Measurement Parameters

The gun (with tracer unit) at 1m and grenade at 2.5m measurement data recorded was used for the graph below to ascertain which measurement parameter is the worst-case.

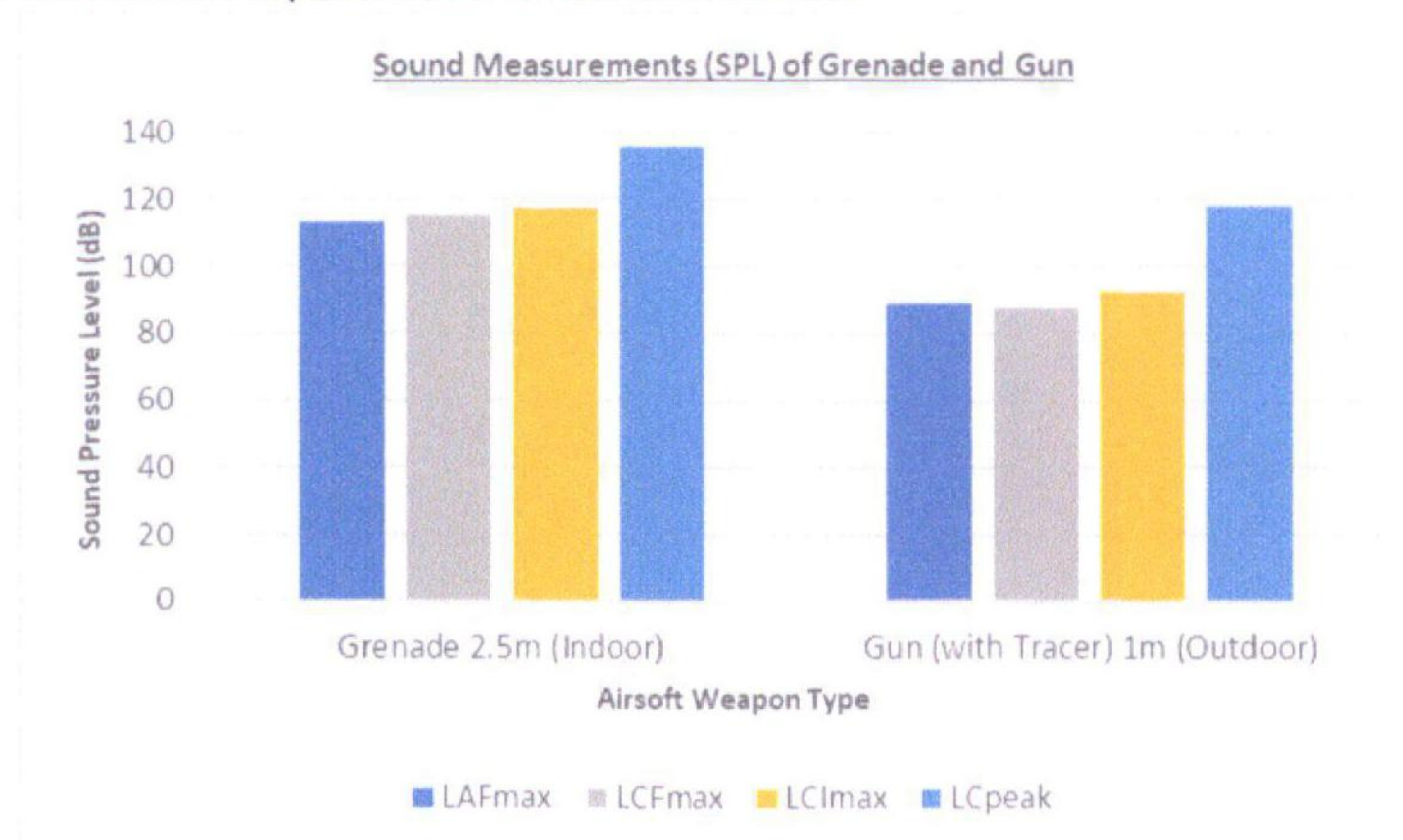


Figure 5.2: Sound measurements of an airsoft gun with tracer and a grenade

The data measurement chart (above) in Figure 5.2 is a reinforcement of the result seen on the chart in Figure 5.1. The sound level in all measurement parameters is higher for the grenade. The LCPeak displays the highest levels of sound, however there is no frequency data that corresponds with it as it is an average generated by the sound meter.

Grenade sound measured at ground floor level (shopping centre walkway)

	Measurement Parameter Average (dB)				
Weapon Position	LAFmax (dBA)	LZFmax (dBZ)	LCFmax (dBC)	LCImax (dBC)	LCPeak (dBC)
Grenade 2.5m Lower Ground	113.7	100.9	115	117.6	135.6
Grenade Ground Floor	46.6	38.3	57.6	58.8	68.2
Reduction	67.1	62.6	62.4	65.4	72.3

Table 5.1: Sound measurement data and parameter comparison in the venue and through the floor above

The table above shows that the worst-case data measurement parameter is the LCPeak. However, there is no supporting frequency data to understand the levels, as the 'C' weighted Peak values are averages calculated by the sound meter. The LZFmax and LAFmax are data parameters that can be further investigated; these are shown in Table 5.2 & 5.3.

	Octave Band Centre Frequency												Average	
LZFmax (dBZ)	8 Hz	16 Hz	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	16 kHz	dB(Z)	dB(A)
Grenade 2.5m LG	115	112	107	105	102	102	107	110	108	105	101	96	106	114.3
Grenade GF	54	51	51	50	54	51	44	40	45	32	22	36	44	49.4
Reduction	61	61	54	55	48	51	63	70	63	73	81	60	62	80.2

Table 5.2: Airsoft Grenade LZFmax (dB) Noise Break out Octave Analysis

The average reduction provided by the floor when comparing the sound measurement of the airsoft grenade in the lower ground airsoft venue and the ground floor shopping centre walkway is 62dB LZFmax. The highest reduction in LZFmax is concentrated in the 1kHz to 16kHz region. Human hearing is most sensitive between 2kHz & 5kHz. The lowest reduction is below 125Hz; however, the sound levels are still approximately above the airborne $D_{nT,w} + C_{tr}$ of 45dB in Building Regulation Part E guidance (designed for residential properties). Guidance on the sound level difference will be discussed further in report JA0581B.

The 'A' weighted LZFmax sound levels display the performance of the floor in comparison to how the human ear responds to the frequencies. It could be argued that due to the concentration of sound in the low frequency region that the 'Z' weighted level is more relevant.

There is a significant difference between the sound level measured inside the venue on the lower ground floor and on the ground floor of the Kingsway centre. Lower frequencies (below 315Hz) are typically the most difficult to mitigate as they are commonly only treated with a high-density material and isolation. Vibration also occurs at low frequency. These elements are tested further with the sound insulation tests on the floor construction in Report JA0581B.

	Octave Band Centre Frequency												Average
LAFmax (dBA)	8 Hz	16 Hz	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	16 kHz	dB(A)
Grenade 2.5m LG	41	56	69	79	86	94	105	110	110	106	100	90	114.6
Grenade at Gr Floor Level	-21	-2	14	25	37	41	41	40	46	33	21	27	48.5
Reduction	61	58	55	54	49	53	64	70	64	73	79	63	80.3

Table 5.3: Airsoft Grenade LAFmax (dB) Noise Break out Octave Analysis

The A-weighted equivalent sound level (of the LZFmax) displays a much higher performance at lower frequencies because of how the human ear responds to them. A full comparison of the A, Z & C weighted LZFmax data is displayed in Appendix A-1. 'C' weighted is normally used where the sound levels have high component in the low frequency range. However, in the following report (JA0581B) the 'Z' weighted LZFmax is used as it corresponds to D_{nTw} sound insulation results and assessment criteria in BB93 and BS8233.

5.2 Summary of Test Results

- All measurement data parameters showed that the grenade is the worst-case airsoft weapon under testing, generating sound pressure levels over 135dB LCPeak at 2.5m.
- The grenade generated the largest component of sound in the frequency range 315-5000Hz.
- The floor construction at the site performs most effectively at higher frequencies from 1kHz which is where human hearing is sensitive.
- On converting the 'Z' flat frequency data to 'A' weighted data there is a significant reduction in sound transfer between the lower ground and ground floor. This can be related to how the human ear perceives the sound.
- Although LCPeak displays the worst-case sound levels, there is no corresponding frequency data to allow further analysis. Therefore, LZeq, LZFmax & LAFmax indoor will be used for analysis in the subsequent report JA0581B as they can be utilized in sound insulation calculations and compared with known criteria.
- The sound measurements taken indoors will be used for report JA0581B as they can be compared with the sound insulation test measurements which include room characteristics, flanking and workmanship. This will more accurately represent the performance of existing floor/wall constructions on site and their resistance to the passage of sound.

5.3 Subjective Assessment

During both the outdoor and indoor measurements, the grenade was clearly the louder of the two weapons. The sound of both weapons was heard instantaneously after either the grenade was dropped, or the gun was fired, with little time related sound data to measure. The grenade is designed to create a shock from anyone nearby which determines the instantaneous nature of the sound.

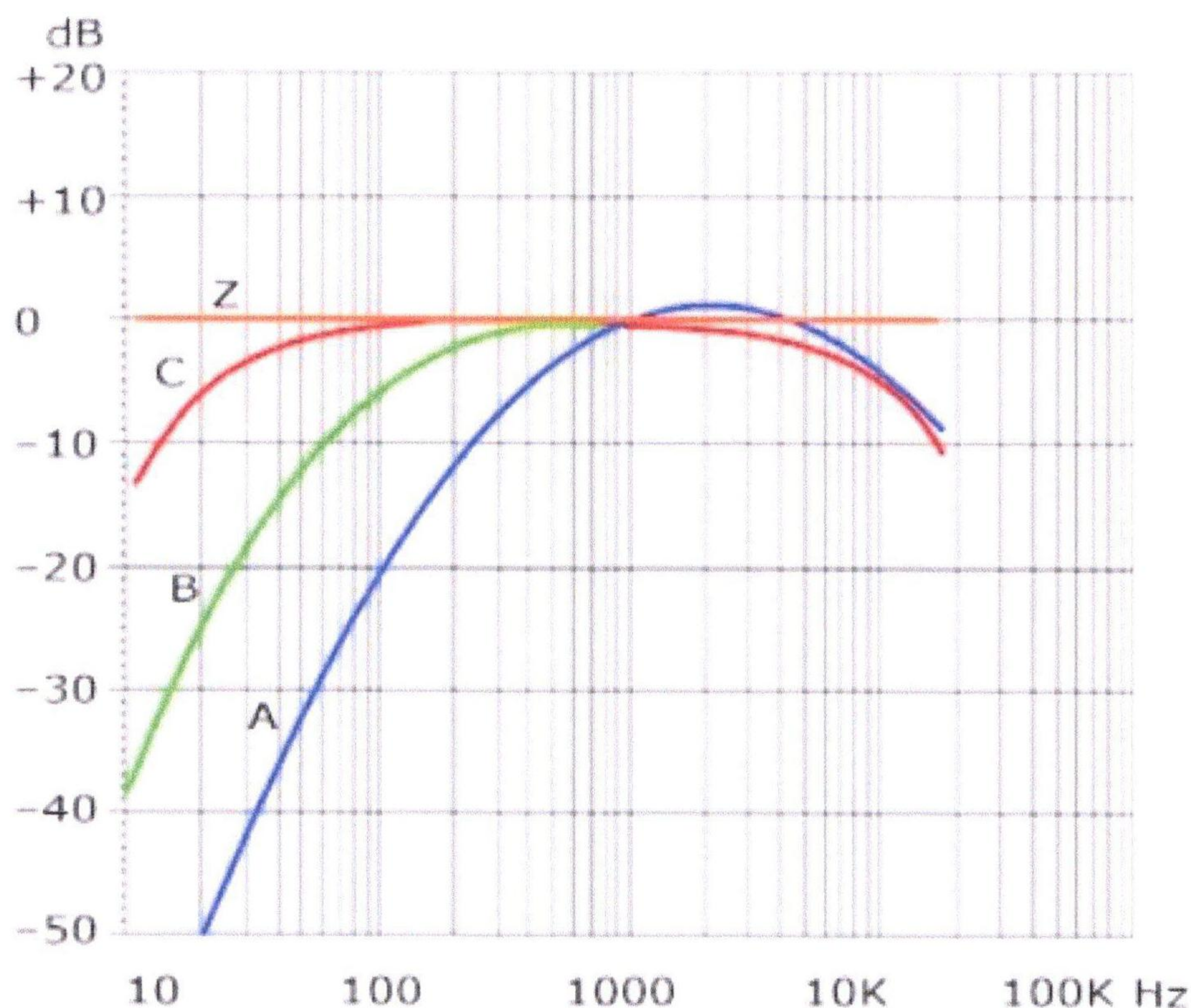
6.0 Limitations

Data measurement 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 in the specific environment of the site stated in the Introduction of this report. The results cannot be transferred to any other construction or building type.

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.

7.0 Definitions

- Equivalent continuous sound level - The steady sound level which over a given period of time has the same total energy as the fluctuating noise.
- LAeq - A-weighted frequency spectrum for the equivalent continuous sound level. A-weighting is based on the 40 phon contour curve which represents human hearing.
- LAFmax - The maximum RMS sound level with A-weighted frequency response and Fast time constant.
- LAI - A-weighted impulse measurement dB(AI) (Defined in Section 2.4)
- LAImax - The maximum RMS sound level A-weighted impulse measurement dB(AI)
- LCImax - The maximum RMS sound level C-weighted impulse measurement dB(AI)
- LCpeak (Peak Sound Level) - This is the peak level of the sound pressure wave with no time constant applied. For Noise at Work measurements the Peak level should be C weighted
- LLCFmax - The maximum RMS sound level with C-weighted frequency response and Fast time constant.
- LZeq - A 'zero' weighted frequency spectrum for the equivalent continuous sound level. A linear time averaged sound level over the measurement period.
- LZFmax (LfFmax) - The maximum RMS sound level with Z-weighted frequency response and Fast time constant.
- A, C and Z Frequency Weighting Filters



- A-weighting is the 'common' name for frequency-weighted sound levels, measured over the 'A' frequency range, shown in the above graph and compatible with the loudness rating of low and medium sound levels. The graphs are based on the 'pure tone' equal loudness contours.
- C-weighting is used for high level measurements and peak sound pressure levels, approximately following the 100 phon curve and reported as dBC, dB(C) or LC, LCE, LCEq etc., = x dB. The A-weighting curve is used extensively for general purpose noise measurements but the C-weighting correlates better with the human response to high noise levels and therefore noise induced hearing loss.

- Z-weighting, the Z is for 'zero' frequency-weighting, implying no weighting across the audio spectrum. In reality the range is 10 Hz to 20 kHz ± 1.5 dB. Introduced in 2003 (IEC 61672) to replace the Flat or Linear Filters.
- Maximum, Minimum and Peak Sound Level
- The maximum and minimum sound levels are simply the highest and lowest time-weighted sound level measured. Be careful with the Peak, as the terms "Peak" and "Maximum" mean very different things in the world of sound level meters.
- Peak Sound Pressure - The Peak is not the same as the Maximum Sound Level. The Peak, referred to as the L_{peak} or sometimes L_{pk} , is the maximum value reached by the sound pressure. There is no time-constant applied and the signal has not passed through an RMS circuit or calculator. This is the true Peak of the sound pressure wave.

8.0 Appendix

8.1 Appendix A-1: Frequency Analysis LZFmax SPL of Grenade at 2.5m

'Z', 'C' & 'A' weightings

