

SANDY BROWN

Consultants in Acoustics, Noise & Vibration

21161-R03-A

20 July 2021

Hilton House, Manchester

Basement gym acoustic report

London, Manchester, Edinburgh, Birmingham, Belfast

Sandy Brown Ltd

Registered in England & Wales

No. 13227735

post@sandybrown.com

www.sandybrown.com

Registered Office: 55 Charterhouse Street, London EC1M 6HA

SANDY BROWN

Consultants in Acoustics, Noise & Vibration

Version	Date	Comments	Author	Reviewer
A	20 Jul 21		Kane Mitchell	Matthew Robinson

Disclaimer

This report has been prepared for the sole benefit and use of our client based on their instructions and requirements. Sandy Brown Ltd extends no liability in respect of the information contained in the report to any third party.

Summary

Sandy Brown have been appointed by Cert Property Limited to undertake acoustic testing and provide acoustic design advice for the proposed basement gym at Hilton House, Manchester.

This report provides a discussion of acoustic performance requirements, the acoustic testing carried out on site and design guidance.

Impact noise transfer measurements from gym weight drops have been carried out to assess the currently installed rubber gym floor and to determine a suitable resilient floor build-up for the free-weight area of the gym where weights are to be dropped.

Airborne sound insulation testing has previously been undertaken between the basement gym and the ground floor building reception, cafe and rear commercial unit. Operational noise limits have been set accordingly to control operational noise transfer and breakout. These limits have been included in this report for reference.

A summary of the key points of this report is provided below:

- The gym is to be operated by personal trainers and gym users will be supervised at all times. The gym has a policy of no weights being dropped in order to prevent gym equipment from being damaged.
- With the currently installed rubber gym floor, impact noise transfer, to all adjacencies, from the 50 kg dumbbell being dropped exceeds the proposed criteria.
- With 50 kg dumbbell weight drops carried out on resilient floor type 2 and type 3, impact noise transfer was not audible in the adjacent spaces and the proposed impact noise transfer criteria was achieved.
- As such, any areas where free-weights are to be dropped resilient floor type 2 or type 3 should be installed.
- A 100 kg barbell was also dropped onto the currently installed rubber gym floor, which resulted in similar levels of impact noise transfer to the 50 kg dumbbell.
- A deadlift platform is to be installed which was not present at the time of testing. With this deadlifting platform installed, it is expected that impact noise transfer will be controlled to a similar level as resilient floor type 2 and type 3. As such, it is expected that the proposed impact noise transfer criteria will be complied with.
- Operational noise limits were previously set out in Sandy Brown report *21161-R02-A Acoustic testing report* dated 5 June 2021. These have been provided for reference.

Contents

1 Introduction 5

2 Proposed development..... 5

3 Basis of report 6

4 Performance criteria 7

5 Acoustic testing..... 7

6 Operational noise..... 12

7 Design guidance 13

8 Construction (Design and Management) Regulations 14

Appendix A 15

 Glossary of terms 15

Appendix B 19

 Equipment information..... 19

1 Introduction

Sandy Brown have been appointed by Cert Property Limited to undertake acoustic testing and provide acoustic design advice for the proposed basement gym at Hilton House, Manchester.

This report provides a discussion of acoustic performance requirements, the acoustic testing carried out on site and design guidance.

Impact noise transfer measurements from gym weight drops have been carried out to assess the currently installed rubber gym floor and to determine a suitable resilient floor build-up for the free-weight area of the gym where weights are to be dropped.

2 Proposed development

2.1 Proposals

A gym is operating within the basement unit of Hilton House, Manchester.

The gym operates as a private personal training space. All gym users are supervised by a personal trainer at all times. The gym has a policy of no weights being dropped in order to prevent gym equipment from being damaged.

The gym will be able to operate during the daytime (07:00-23:00) during the daytime and (06:00-07:00) during the night-time.

A photograph of the basement unit gym is provided in Figure 1.

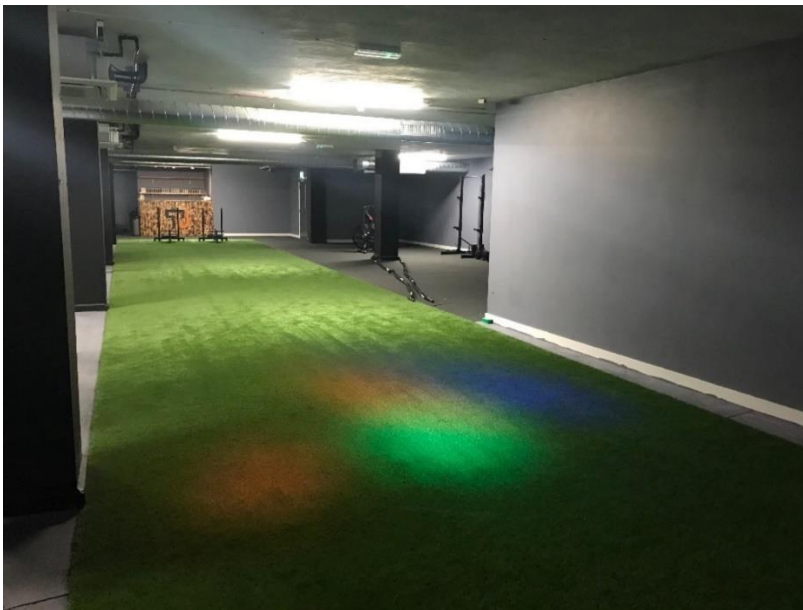


Figure 1 Photograph of the basement unit gym

2.2 Adjacent spaces

The ground floor comprises of the building reception, a cafe and an unoccupied rear unit.

Approximately 20 m to the south west of the gym are a number of residential apartments within Dale House.

2.3 Existing constructions

The basement unit gym is fitted out. The soffit of the basement gym unit is concrete. The walls are predominantly concrete, with newly constructed drywall partitions. The columns of the basement unit are concrete. The floors of the gym are a mixture of:

- Rubber gym flooring to free-weight and machine areas.
- Astroturf to areas for sled runs.
- Painted concrete floor elsewhere.

3 Basis of report

3.1 Design information

This report is based on the following:

- Basement and ground floor general arrangement layouts provided via email on 23 March 2021.
- The results of the gym testing undertaken on 13 July 2021.
- Operational noise levels detailed within Sandy Brown report *21161-R02-A Acoustic testing report* dated 5 June 2021.

3.2 Standards and guidance

The design of the proposed buildings takes account of the design criteria set out in the following documents:

- BS 8233: 2014 *Sound insulation and noise reduction for buildings – code of practice*
- CIBSE Guide A: *Environmental design* (2015)
- The Control of Noise at Work Regulations 2005
- World Health Organisation *Guidelines for Community Noise* 1999 (WHO Guidelines)
- The Disability Discrimination Act 2004.

4 Performance criteria

4.1 Development criteria

4.1.1 Impact noise transfer

There are no British Standards or guidance documents that set criteria for structure-borne noise from the impacts of free-weights and weights machines.

It is recommended that structure-borne noise transfer due to the dropping of gym weights within the basement unit gym is limited to L_{AFmax} 35 dB in Dale House residential apartments. This limit is 10 dB below the WHO guidelines which indicate that L_{AFmax} 45 dB is the onset of sleep disturbance. The limit is above the internal noise criterion of (L_{Aeq} 30 dB in bedrooms and L_{Aeq} 35 dB in living areas); however, mitigation measures will be designed so the limit is not exceeded.

It is recommended that structure-borne noise transfer due to the dropping of gym weights within the basement gym is limited to L_{AFmax} 45 dB in ground floor building reception, cafe and rear commercial unit.

5 Acoustic testing

Airborne sound insulation testing between the basement gym and the ground floor building reception, cafe and rear commercial unit was previously undertaken on 28 April 2021 by Kane Mitchell and Jose Gonzalez. Details of this testing can be found in Sandy Brown report 21161-R02-A *Acoustic testing report* dated 5 June 2021.

Impact noise transfer measurements from the basement gym to the ground floor building reception, cafe and rear commercial unit, as well as to a residential apartment within the Dale House was carried out on 13 July 2021 by Kane Mitchell and Jose Gonzalez.

5.1 Impact noise transfer

Impact noise transfer measurements from gym weight drops have been carried out to assess the currently installed rubber gym floor and to determine a suitable resilient floor build-up for the free-weight area of the gym where weights are to be dropped.

All weights were dropped from knee height (approximately 0.5 m) on to the chosen flooring type. All flooring types were placed directly onto the concrete floor slab. The following weights were dropped:

- 50 kg dumbbell (which is the maximum dumbbell weight within the gym).
- 100 kg barbell (which is typically the maximum barbell weight used by gym users). Further commentary on this is provided in Section 7.1.2.

5.1.1 Measurement locations

The location of the weight drops within the basement gym is shown in red in Figure 2.

The approximate location of the noise measurements in Dale House residential apartment is shown in green, however these measurements were undertaken at first floor level.

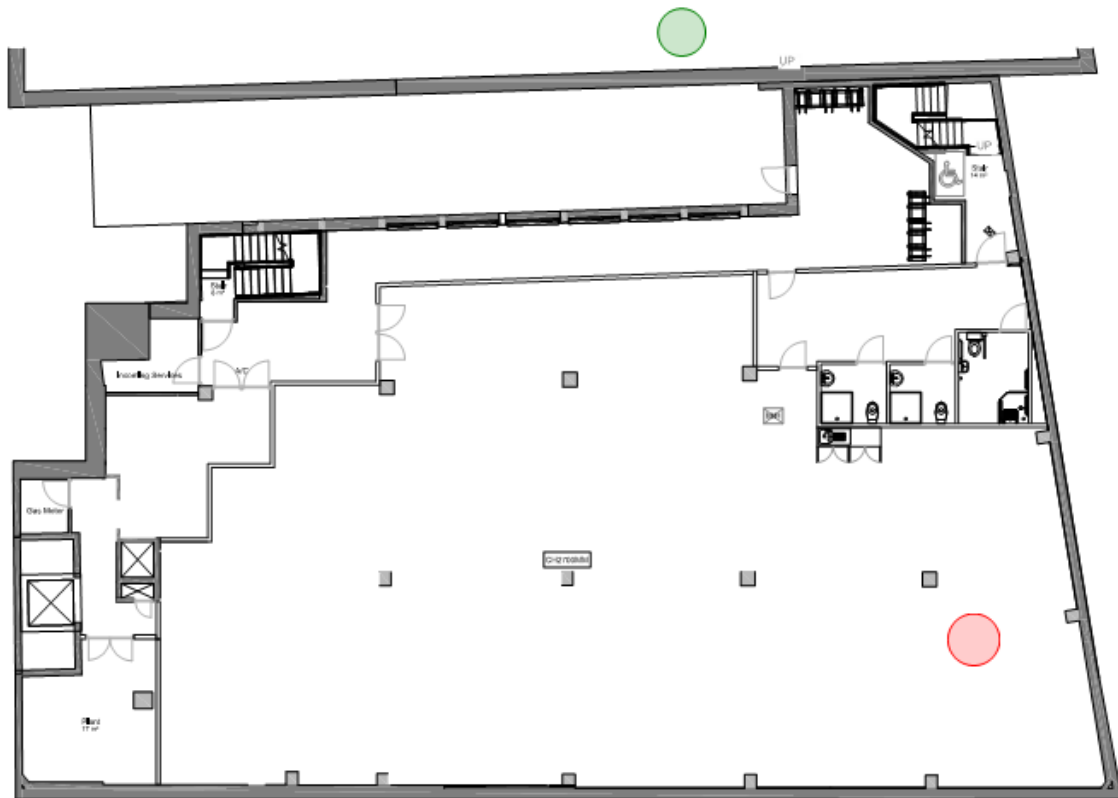


Figure 2 Weight drop location – Basement gym

5.1.2 Resilient flooring types

A number of resilient flooring types were tested, and their build-ups are given below:

1. Existing rubber gym flooring approximately 20 mm thick
2. GenieMat FIT70 gym tile (overall depth 70 mm)
3. 40 mm Sportec gym tile, 17 mm Acousticork U71 resilient layer (overall depth 57 mm)

An image of the currently installed rubber gym flooring is provided in Figure 3 and the other resilient flooring types are shown in Figure 4.



Figure 3 Currently installed rubber gym flooring



Figure 4 Currently installed rubber gym flooring and other resilient floor types

5.1.3 Impact noise transfer measurement results

Each gym free-weight drop event was measured over a short period to measure the maximum noise levels generated. Three repetitions of each gym weight being dropped were measured with flooring type 1, and then two weight drops with flooring type 2 and type 3, the results of which are presented in Table 1.

Due to time restrictions on site, it was only possible to undertake two impact noise transfer measurements of flooring type 1 with the ground floor cafe.

The measurements which were undertaken are however considered to be representative.

No tactile vibration was perceptible during any of the measurements.

Table 1 Summary of impact noise transfer measurements results

Measurement location	Resilient floor type	Maximum sound pressure level, L_{AFmax} (dB)
<i>Building reception</i>	1	51
	1	47
	1	50
	2	51
	2	53
	3	49
	3	44
<i>Cafe</i>	1	60
	1	60
<i>Rear commercial unit</i>	1	50
	1	53
	1	51
	2	46
	2	47
	3	50
	3	45

Measurement location	Resilient floor type	Maximum sound pressure level, L_{AFmax} (dB)
<i>Dale House residential apartment</i>	1	33
	1	35
	1	37
	2	28
	2	29
	3	27
	3	31

Background noise level measurements were undertaken in all of the measurement locations. The measured background noise levels are set out below for reference:

- Building reception – $L_{A901min}$ 35 dB
- Cafe – $L_{A90 1min}$ 53 dB
- Rear commercial unit – $L_{A90 1min}$ 39 dB
- Dale House residential apartment – $L_{A90 1min}$ 24 dB

Every effort was made to avoid extraneous noise impacting the measurement results, by repeating measurements where extraneous noise affected the results. Any clearly extraneous measurements have been omitted from the assessment.

The finishes in the receiving spaces were representative of their respective uses with the exception of the rear commercial unit. This unit was not fitted-out when the testing was undertaken and is therefore considered a worst-case scenario, as reverberation time would reduce when fitted out, and therefore the noise transfer would also be reduced.

5.1.4 Discussion of impact noise transfer measurement results

The results of the impact noise transfer measurements are provided in Table 1.

In all spaces, the maximum noise levels measured with flooring type 1 were the result of the weight drops. Due to activity noise within the cafe, which is reflected in the measured background noise level, it was difficult to distinguish between general hubbub and the actual weight drop impact noise transfer. The reported max noise levels are however considered to be accurate and not the result of extraneous noise.

For flooring type 2 and type 3, the maximum noise levels measured were not the result of the weight drops but were instead the result of extraneous noise, such as passing vehicles and pedestrians. Subjectively, noise resulting from weight drops was inaudible. The results are further discussed within Section 7.

5.2 Airborne sound insulation

Airborne sound insulation tests between the basement gym and the building reception, cafe and rear commercial unit were previously undertaken in order to set operational noise limits within the basement gym. Further details of these tests are provided in Sandy Brown report *21161-R02-A Acoustic testing report* dated 5 June 2021.

Sound insulation tests were undertaken between the basement gym unit and the ground floor spaces. The results of these tests are summarised below for reference:

- Basement gym unit to reception – $D_{nT,w}$ 59 dB
- Basement gym unit to cafe – $D_{nT,w}$ 55 dB
- Basement gym unit to rear commercial unit – $D_{nT,w}$ 53 dB.

5.3 Loudspeaker operational noise measurements

The measured noise levels of the tenants bluetooth speaker system in the gym were in the region of L_{Aeq} 72 dB. Subjectively, no music was audible within any of the ground floor spaces whilst the tenant had their sound system operating. As such, the proposed bluetooth speaker system operating at this level has been assessed to be suitable.

6 Operational noise

6.1 Operational noise limits

Operational noise limits were previously set out within Sandy Brown report *21161-R02-A Acoustic testing report* dated 5 June 2021. These operational noise limits are set out in Table 2 for reference.

Table 2 Basement gym operational noise limits

	Maximum operational noise level, $L_{eq,5mins}$ (dB)							
	Octave-band centre frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Basement gym operational noise limits	76	76	77	75	78	78	76	76

6.1.1 Guidance if fixed loudspeakers are used

Due to the basement gym tenant using a bluetooth speaker system, it would not be practical to implement a sound level limiter.

If a fixed loudspeaker system were to be used, it is recommended that:

- Loudspeakers are mounted to the walls of the basement gym rather than to from the soffit in order to control structure borne noise transfer. Ideally, resilient loudspeaker mounts should be provided in order to help further control noise transfer to the ground floor spaces.
- An electronic sound level limiter be provided in order to ensure the noise levels within the gym do not exceed those set out in Table 2.

6.1.2 Potential further enhancements for higher operational noise levels

If operational noise levels greater than those set out in Table 2 were required, enhancements would need to be provided. These enhancements could include, but are not limited to, a combination of the following:

- Providing a sound insulating ceiling to the basement gym unit.
- Providing acoustically rated doorsets between the gym unit and circulation spaces / lift lobby.
- Providing plasterboard linings to any columns/common elements between the basement unit and ground floor spaces.
- Providing plasterboard linings to flanking partitions that extend from basement level to ground floor.

7 Design guidance

7.1.1 Dumbbell free-weight area floor

For the gym free-weights area, resilient floor types 2 and 3 are expected to be capable of suitably controlling impact noise transfer such that the criteria in Section 4.1 are achieved in the ground floor areas as well as within the Dale House residential apartments when considering limiting the gym free weights to 50 kg.

Resilient floor type 2 and type 3 comprised of the following:

- Resilient floor type 2 comprises of GenieMat FIT70 gym tile (overall depth 70 mm)
- Resilient floor type 3 comprises of 40 mm Sportec gym tile, 17 mm Acousticork U71 resilient layer (overall depth 57 mm).

It is therefore recommended that in any areas where free-weights are to be dropped, a resilient floor similar to the specification as those above be provided.

7.1.2 Barbell area floor

As discussed in Section 5.1, a 100 kg barbell was also dropped onto the installed rubber gym flooring. This resulted in similar levels of impact noise transfer to the 50 kg dumbbell as detailed in Table 1, which exceeded the design criteria.

A deadlifting platform is to be installed within the gym (which was not installed when the impact noise transfer testing was undertaken). Deadlifts will be restricted to this area. With the deadlift platform installed and considering a maximum barbell weight of 100 kg, it is expected that impact noise transfer will be controlled to a similar level to the 50 kg dumbbell dropped onto resilient floor type 2 and type 3 and would therefore comply with the impact noise transfer criteria, though this could not be confirmed on site.

8 Construction (Design and Management) Regulations

The Construction (Design and Management) Regulations 2015 places legal duties on virtually everyone involved in construction work. Those with legal duties are commonly known as 'dutyholders' and include clients, designers, contractors and workers.

Typical risks specifically associated with acoustic design are:

- Access at height to install and to maintain such elements as acoustic absorbers
- Manual handling of heavy building elements such as high density concrete blocks.

Acoustic treatment is proposed which will require installation at height, eg, soffit of spaces. However, this would be required in any event for installation of ceiling finishes, lighting, etc and is therefore not a risk specifically related to the acoustic design.

Man-made mineral fibres (MMMF) are used extensively in the construction industry and these are sometimes specified for their acoustic properties. When contractors make use of MMMF they should act on relevant legislation and the latest guidance issued by the Health and Safety Executive.

The above risks are not unusual and would be appropriately managed by a competent contractor.

Appendix A

Glossary of terms

General terms

Absorptive material	Material that absorbs sound energy. Soft or porous finishes such as mineral fibre are effective sound absorbers.
Acoustic absorption	The conversion of sound energy, often by the use of a porous material. It is a term used to describe the amount of sound absorbed by a finish or object within a room.
Airborne sound	Sound propagating through the air.
Airborne sound insulation	The ability of building elements or structures to reduce airborne sound transmission.
Density	Mass per unit volume, expressed in kilograms per cubic metre (kg/m^3).
Direct sound transmission	The process in which sound that is incident on one side of a building element is radiated by the other side.
Flanking element	Any building element that contributes to the sound transmission between rooms in a building that is not the separating element in question. It is typically an element which continues past the separating element
Flanking sound transmission	Sound transmitted between rooms via flanking elements instead of directly through separating elements, or along any path other than the direct path.
Floating/isolated floor	A floating or isolated floor consists of a floating layer that is decoupled from the main structure by a resilient layer or other resilient element (see also 'Resilient layer' and 'Floating/isolated layer'). The type of resilient element depends on the level of isolation required.
Floating/isolated layer	A surface that rests on a resilient layer or other resilient element and is therefore isolated from the main structure (see also 'Floating/isolated floor' and 'Resilient layer').
Frequency	The number of cycles per second. The unit of frequency is the Hertz (Hz). Frequency gives a sound its distinctive tone.
Frequency band	A continuous range of frequencies between stated upper and lower limits (see also 'Octave band' and 'One-third octave band').
Impact sound	Sound resulting from direct impact (such as footsteps) on a building element.
Impact sound insulation	The ability of building elements or structures to reduce impact sound transmission.
Isolation	The absence of rigid connections between two or more building elements.
Mass per unit area	The mass per unit area, expressed in terms of kilograms per square metre (kg/m^2). Also known as 'surface density'.
Resilient layer/element	A layer or other resilient element that isolates a floating layer from a base floor and the surrounding walls.
Reverberation	The persistence of sound in a space after a sound source has stopped.
Reverberation time	The time, in seconds, taken for the sound in a room to decay by 60 dB after a sound source has been stopped.

Separating element	An element (such as a wall, floor, door, window) which separates buildings or parts of buildings.
Sound pressure level	A logarithmic measure of the effective sound pressure of a sound relative to a reference value, measured in decibels, dB. Sound pressure levels are dependent on the conditions under which they are measured.
Spectrum	The composition of a particular sound in terms of separate frequency bands.
Structure-borne sound	Sound which is transferred by vibration via the structure of a building.

Acoustic parameters

'A' weighting	Frequency weighting based on the frequency response of the human ear which has been found to correlate well with the subjective response to sound.
Decibel (dB)	A logarithmic unit used for many acoustic values to indicate the level with respect to a reference level
D_{nT}	The difference in sound level between a pair of rooms, in a stated frequency band, normalized for the reverberation time. A higher numerical quantity represents a better performance.
$D_{nT,w}$	A single number weighted quantity which characterizes the airborne sound insulation between rooms, corrected for reverberation time. A higher numerical quantity represents a better performance.
Hz	Hertz (Hz) is the unit of frequency (see also 'Frequency')
$L_{A90,T}$	The A-weighted sound pressure level exceeded 90% of the measurement period (T) over which a noise is measured (ie, the quietest 10% of the period). When not weighted it is denoted $L_{90,T}$. This parameter is generally considered to be representative of a constant noise source, or background noise level.
$L_{Aeq,T}$	Equivalent A-weighted sound pressure level of a steady noise that has the same acoustic energy as a fluctuating noise over the measurement period (T). When not weighted it is denoted $L_{eq,T}$.
$L_{Amax,T}$	The highest A-weighted sound pressure level measured in the period (T) with either fast (L_{AFmax}) or slow (L_{ASmax}) time weightings. When not weighted it is denoted L_{Fmax} or L_{Smax} .
Octave band	A frequency band in which the upper limit of the band is twice the frequency of the lower limit.
One-third octave band	A frequency band in which the upper limit of the band is the cube root of two times the lower limit of the band or more simply one third of an octave band.
R	Sound reduction index. A quantity, measured in a laboratory, which characterises the airborne sound insulation of a material or building element in a stated frequency band. A higher numerical quantity represents a better performance.

R_w	Weighted sound reduction index. A single number quantity which characterises the airborne sound insulation of a material or building element in the laboratory. A higher numerical quantity represents a better performance.
R'	Apparent sound reduction index. The on-site equivalent of the sound reduction index, R , which is measured in the presence of flanking paths. A higher numerical quantity represents a better performance.
R'_w	Apparent weighted sound reduction index. The on-site equivalent of the weighted sound reduction index, R_w . A higher numerical quantity represents a better performance.
T_{mf}	The arithmetic average of the reverberation time in the 500 Hz, 1 kHz and 2 kHz octave bands (see also 'Reverberation time').
α_w	Weighted absorption coefficient – a quantity characterising the effectiveness of a sound absorbing surface. The proportion of sound energy absorbed is given as a number between zero (for a fully reflective surface) and one (for a fully absorptive surface).

Appendix B

Equipment information

Equipment

The measurements were taken using a BK2250 sound level meter.

Calibration details for the equipment used are provided in Table A1.

Table A1 Equipment calibration data

Equipment description	Type/serial number	Manufacturer	Calibration expiry	Calibration certification number
Sound level meter	2250/3011964	Brüel & Kjær	4 Sep 21	UCRT19/1970, UTRC19/1976
Microphone	4189/3100176	Brüel & Kjær	4 Sep 21	UCRT19/1970, UTRC19/1976
Pre-amp	ZC0032/26376	Brüel & Kjær	4 Sep 21	UCRT19/1970, UTRC19/1976
Calibrator	4231/3019123	Brüel & Kjær	3 Sep 21	UCRT19/1969

^[1] Calibration of the meters used for the measurements is traceable to national standards. Calibration certificates for the sound level meters used in this survey are available upon request.

Calibration checks were carried out on the meter and their measurement chains at the beginning and end of the testing. No significant calibration deviation occurred.