Acoustic Assessment Report

Proposed Pilates & Exercise Studio
Ground Floor Commercial Unit
93-95 Whitchurch Road
Cardiff CF14 3JP

Report reference: AE0068

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Prepared for:

Betsan Cooper

Prepared by:

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	Prepared by	
Name	Stratton Barrett MIOA	
Signature		

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This report is provided for the sole use of the named client and is confidential to them and their project team. No responsibility is accepted to other parties and the content of this report is non-transferable.

0.5 Executive Summary

Aether Acoustics has undertaken an acoustic assessment of the proposed fitness studio at 93-95 Whitchurch Road, Cardiff.

The sound insulation provided by the existing floor, while potentially failing to meet Part E Building Regulations in some areas, would provide sufficient reduction of Pilates / floor-based exercise activity noise and low-level background music, based on the description of the proposal below.

It is understood that background music will be provided using a small portable loudspeaker and as such, no fixed sound system will be proposed.

Based on the proposed activities and associated equipment to be installed, it would not be expected that significant levels of vibration / impact noise will be generated. However, the proposed new floor finish should incorporate a cushioned backing with the aim of minimising any potential for occasional light impacts to transmit into the building structure.

It would be recommended that reverberation should be suitably controlled within the space, along with provision of acoustic seals to internal access doors serving the studio.

1.0 Introduction

Aether Acoustics is appointed by Betsan Cooper to carry out a noise control assessment of a proposed exercise studio, to be located in an existing ground floor commercial unit at 93-95 Whitchurch Road, Cardiff.

The proposal is understood to include Pilates and Yoga classes as well as pre and post-natal physical rehabilitation for women, including strength and conditioning exercise. The business would operate between 07:00 – 21:00hrs throughout the week.

The commercial unit is directly below a pair of residential apartments to the 1st floor and as such, airborne and structure borne sound insulation needs to be considered.

Cardiff City Council imposed the following conditions on planning approval (23/01565/FUL):

Item 5:

A scheme of sound insulation works to the floor/ceiling/party wall structure between the application premises and any adjoining residential units shall be submitted to and agreed by the Local Planning Authority in writing and implemented prior to occupation.

Item 7:

Prior to amplified music being played in any room it shall be insulated for sound in accordance with a scheme to be submitted and approved in writing by the Local Planning Authority and a dedicated in-house sound system shall be used exclusively for the amplification of any music and speech produced in association with activities undertaken within the health and fitness studio. The mounting of all loudspeaker systems should be considered by a suitably qualified acoustician to ensure that they are well isolated from the building structure, typically through the use of independent stands or resilient fixings to achieve an isolation of at least 90%.

This report has been produced as supporting information for discharge of Conditions 5 & 7 detailed above and addresses the potential noise impact of the proposed facility on 1st floor noise sensitive receptors. The acoustic assessment includes sections covering the following aspects:

- The results of baseline sound insulation tests through the existing 1st floor structure.
- An assessment of likely activity and background music sound levels inside the exercise studio, based on the proposal.
- Review of appropriate standards relating to commercial noise in this context.
- Criteria for acceptable noise levels inside 1st floor habitable rooms, based on recognised guidance.
- A review of the existing building in terms of potential airborne and structure borne noise transmission, along with a review of the proposed fitout.
- Recommendations on additional remedial measures with the aim of minimising the noise impact of the proposal.

2.0 Baseline Sound Insulation Tests

In order to evaluate the level of sound insulation provided by the existing 1st floor structure, airborne sound insulation tests were undertaken on 13th September 2023.

It is understood that the upper floor apartments were converted approximately 10-12 years ago and as such, sound insulation performance would be expected to be in compliance with Part E Building Regulations (2003).

2.1 Measurement Procedures

All tests were carried out in full accordance with ISO 140-4. Calculation of airborne and impact sound insulation values was undertaken in full accordance with ISO 717-1. Procedures contained in Annex B of the Approved Document of the Building Regulations were adhered to.

All measurements were made using a moving microphone with a minimum sweep radius of 0.7m and minimum traverse period of 15s. For each measurement, the minimum averaging time for each third octave band centre frequency is 15s. This method was used in both source and receiver rooms.

2 no. loudspeaker positions were used for airborne measurements with 2 no. 16s traverses measured at each position i.e. 4 no. measurements in total.

At the time of measurement, background noise inside receiver rooms was dominated by road traffic along Whitchurch Road.

The background noise level was measured in order to allow the appropriate corrections to be applied. The measurements were made using the moving microphone method described above, to a minimum 2 no. 16s traverses. Where background noise level difference was less than 10dB a correction was applied to the signal level as detailed in the appropriate section of ISO 140-4.

Measurements of reverberation time were made in receiver rooms using the interrupted noise method; 2 loudspeaker locations were used, with 3 measurements taken around each loudspeaker position.

2.2 Summary of Test Results

The following table summarises the results of the airborne sound insulation tests, with comparison with the minimum required performance for conversion as detailed in Part E Building Regulations. Third octave graphical output for each test result is included in Appendix A of this report.

Test Number	Source Room	Receiver Room	Result D_{nTw}	Result $D_{nTw+Ctr}$	Part E Requirement $D_{nTw+Ctr}$
1	Ground Floor Commercial	Flat 3 Bedroom (1st floor)	48	41	≥43
2	Ground Floor Commercial	Flat 3 Living Room (1st floor)	48	43	≥43

Table 1: Summary of sound insulation test results

It can be seen that, while the performance of the 1st floor between commercial unit and living room would comply with ADE 2003, sound break through levels into the 1st floor bedroom produce a test result approx. 2dB lower than the standard. Analysis of this result would suggest poorer than anticipated performance in low frequency bands (125-160Hz).

Test 2 has a nominally similar result but without the effect of being compromised at low frequencies.

2.3 Background Sound Level

Background sound levels were measured as part of the sound insulation testing, inside the 1st floor apartment (windows closed). The following table provides a summary of the result.

Location	Period	Duration T	$L_{Aeq,T}$	L_{AFmax}	L_{A90}
1st Floor Apartment 3	Daytime	00:03:00	32	44	25

Table 1A: Summary of background sound measurements

The background sound level was dominated by road traffic noise along Whitchurch Road.

3.0 Noise Assessment Criteria

Aether Acoustics has reviewed the following guidance documents and standards with the aim of establishing suitable noise limits inside the upper floor dwellings:

- British Standard 8233: 2014
- World Health Organisation Guidelines on Community Noise

3.1 British Standard 8233: 2014

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

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

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

Table 2: Noise limits inside residential properties suggested in BS 8233

3.3 WHO Guidelines on Community Noise

In 1980 the World Health Organisation proposed environmental health criteria for community noise including consideration of noise levels at which sleep disturbance may take place.

The guidance suggests that a night time internal L_{Aeq} below 30dB is required to preserve the restorative process of sleep. This is equivalent to a free-field level of around 42 to 45dB L_{Aeq} or a façade level of 45 to 48dB L_{Aeq}, assuming open windows.

3.4 Recommended Noise Limit Criteria

Based on the test results and guidance detailed above, the following criterion would be recommended:

- Combined noise levels from the proposal should not exceed 30dB$_{LAeq,15min}$ measured inside 1st floor habitable rooms during all periods of operation (daytime only).

4.0 Noise Assessment

4.1 Analysis of The Proposal and Fitout

It is understood that the studio will typically host Pilates, Yoga and other instructor lead light fitness classes. In addition, physical exercise sessions will be offered, involving use of some basic apparatus, described below.

It can be seen that the proposal could not be described as a gymnasium as such, and will not contain treadmills, cross-training, rowing or other machines typically associated with airborne / structure-borne noise transmission in this context.

Background music would be expected as part of the proposal, however the applicant has made it clear that any music would be played on a small portable loudspeaker – no fixed sound system / loudspeakers would be proposed as part of the fitout.

The following equipment is understood to be proposed:

- Align-Pilates A8 Pro Pilates Reformer

Use of this apparatus is understood not to present the potential for footfall or other impact / vibrational noise.

- Freestanding rack to provide support for suspended exercises.

- Small kettle balls and dumbbells

While dropping of dumbbells etc. could potentially result in a degree of impact noise into the floor structure, it would be anticipated that the proposed Pilates / light workout use of these would be unlikely to present this issue. Local isolation of items on suitably sized / thickness matting as required when in use would likely be sufficient.

At present the commercial unit has a bare concrete floor finish, however a basic sports floor cushioned timber / vinyl product is proposed.

The space is currently highly reverberant and would require some surface treatment with the aim of reducing the reverberation time to a comfortable level for teaching.

4.2 Estimated Activity Noise Levels

The predominant likely noise source inside the space would be speaking voices in a class / group scenario, along with background music.

A single typical speaking voice would generate a level up to approx. 55-60dBA, with a raised voice up to approx. 65dBA. Multiple speaking voices together could potentially generate levels around 66dBL_{Aeq}, depending on the reverberance of the space.

Aether Acoustics has recent historic measurement data for a small typical gymnasium, and while not strictly relevant in this context, the data provide useful guidance on potential background music levels. The data suggest an average level up to approx. 68dB$L_{Aeq15min}$ could be experienced when combined with talking etc.

4.3 Noise Break-Through Calculation

The following table presents an estimate of potential noise break-through from the ground floor studio into the 1st floor bedroom, given the existing performance of the floor and potential activity noise levels in the studio.

Parameter	Octave Band Centre Frequency (Hz)							Total dBA
	63	125	250	500	1k	2k	4k	
Exercise activity noise (including background music) $L_{Aeq,15min}$	60	68	63	65	64	60	54	68
Sound reduction provided by existing 1st floor (worst case test result)	≥18	28	37	47	57	56	66	D_{nTw} ≥44
Reverberation time (s) in 1st floor bedroom (10m^2 common area)	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.5s
Resulting sound pressure level (A-weighted) inside 1st floor bedroom	13	23	16	16	8	5	0	25

Table 3: Noise break-through calculation based on the existing 1st floor construction

It can be seen that, while the sound insulation performance of the existing floor marginally fails to comply with Part E Building Regulations, the frequency content of activity noise in the exercise studio would be unlikely to present an issue in terms of noise break-through.

A predicted receptor level of 25dBA would be min. 5dBA better than the recommended internal ambient noise limits defined in WHO and BS 8233: 2014 guidance for both day and night time periods.

4.4 Reverberation Control

The existing commercial unit was observed to be highly reverberant; as such the reverberation time was measured with the intention of providing advice on reverberation control within the space.

A reduced reverberation time would be beneficial both in terms of potential noise break-through and speech intelligibility / acoustic comfort in the studio (with the associated ability to rely on normal speaking voice levels).

At present the reverberation time as tested was approx. 3.0 seconds. A target reverberation time <1.5 seconds would be desirable (based on BB93 guidance for reverberation time in gymnasiums).

The following table provides results of the reverberation measurements, along with predicted reverberation time based on the addition of approx. 10-12m^2 of Class A acoustic absorber panel to walls and / or ceiling.

Parameter	Octave Band Centre Frequency (Hz)						Average
	125	250	500	1k	2k	4k	
Measured reverberation time (RT60)	≈3.0	≈3.0	3.2	3.6	2.9	2.3	**3.0s**
Class A (NRC 0.95) absorber panel specification (Octave band absorption coefficient)	0.3	0.7	1.0	1.0	1.0	1.0	**0.95**
Predicted reverberation time, installation of approx. 12m^2 of Class A absorber panel*	1.8	1.5	1.4	1.5	1.4	1.1	**1.4s**

* Also includes for the effect of other items in the finished space e.g. matting, equipment etc.

Table 4: Reverberation test results and predicted RT with nom. 12m^2 Class A panels

An example of a suitable Class A acoustic absorber panel would be as follows:

40mm thickness ProSound Acoustic Wall / Ceiling Panels

https://www.soundproofingstore.co.uk/acoustic-wall-panels

A minimum of 10m^2 would be recommended = 7 no. @ 1.2m x 1.2m panels

4.5 Recommended Noise Mitigation Measures

The noise impact from the proposal has been calculated and it would be recommended that this would be within compliance targets defined in various standards.

However, with the aim of minimising any potential nuisance, it would be recommended that the following mitigation measures are incorporated:

- Provision of a basic cushioned floor finish throughout the studio, incorporating a padded backing.
- Installation of approx. 10m^2 acoustic absorber panels to the walls and / or ceiling with the aim of reducing reverberation to a nominal average *RT*=1.5 seconds. Suspension of acoustic panels from the ceiling would improve the absorption efficiency.
- The door providing access to the rear communal corridor should be fitted with acoustic perimeter and threshold seals. Specifications for suitable seals will be provided separately to this report.
- Provision of background music should be via a small portable loudspeaker only; any future proposal to install a fixed sound system would require additional acoustic advice.
- Any free weights / dumbbells should be used on an appropriate floor finish with the aim of avoiding direct contact with the floor if dropped.
- Incorporation of a basic 'traffic light' noise level indicator may also be considered, which would provide a visual indication as to whether sound levels are within the tolerable range as relates the sound insulation of the floor. More advice can be provided on request.

Appendix A

Graphical Results of Sound Insulation Tests

Standardised level difference according to ISO 140-4
Field measurements of airborne sound insulation between rooms

Client:	Betsan Cooper	Project:	93-95 Whitchurch Road
Test number:	1		
Source room:	GF Commercial	Receiver room:	Flat 3 Bedroom 1st Floor

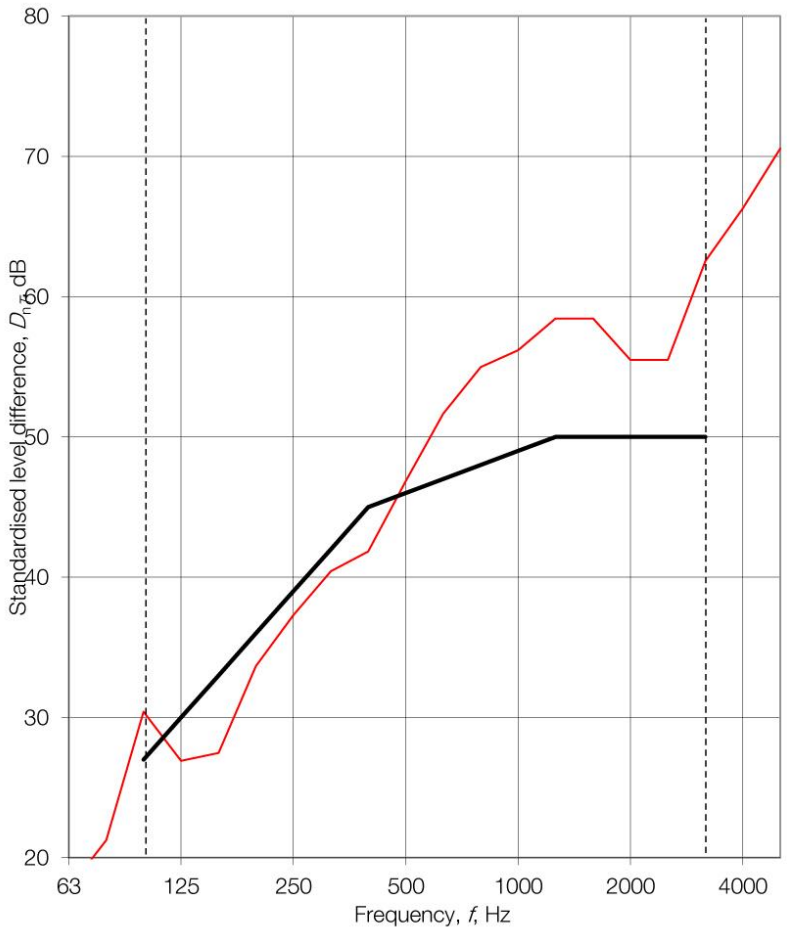
Description and identification of the building construction and test arrangement, direction of measurement:

Converted timber floor

Source room volume: 279 m^3
Receiving room volume: 26 m^3

---- Frequency range according to the
—— curve of reference values (ISO 717-1)

Frequency f Hz	D_{nT} (1/3 octave) dB	
50	16.0	
63	17.8	
80	21.3	
100	30.4	
125	26.9	
160	27.5	
200	33.7	
250	37.3	
315	40.4	
400	41.8	
500	46.8	
630	51.7	
800	55.0	
1000	56.2	
1250	58.4	
1600	58.4	
2000	55.5	
2500	55.5	
3150	> 62.5	*
4000	> 66.3	**
5000	> 70.6	**



Rating according to ISO 717-1

** measurement significantly affected by ambient / activity noise
* measurement partially affected by ambient / activity noise

$D_{nT,w}(C;C_{tr})$ = 48 (-2; -7) dB; $C_{50\text{-}3150}$= -4 dB; $C_{50\text{-}5000}$= -3 dB; $C_{100\text{-}5000}$= -1 dB

$C_{tr,50\text{-}3150}$= -13 dB; $C_{tr,50\text{-}5000}$= -13 dB; $C_{tr,100\text{-}5000}$= -7 dB

Evaluation based on field measurement results obtained by an engineering method

Test date:	13-Sep-23	Name of test institute:	Aether Acoustics
No. of test report:	AE0068		
Report date:	15-Sep-23	Signature:	

Standardised level difference according to ISO 140-4
Field measurements of airborne sound insulation between rooms

Client:	Betsan Cooper	Project:	93-95 Whitchurch Road
Test number:	2		
Source room:	GF Commercial	Receiver room:	Flat 3 Living Room 1st Floor

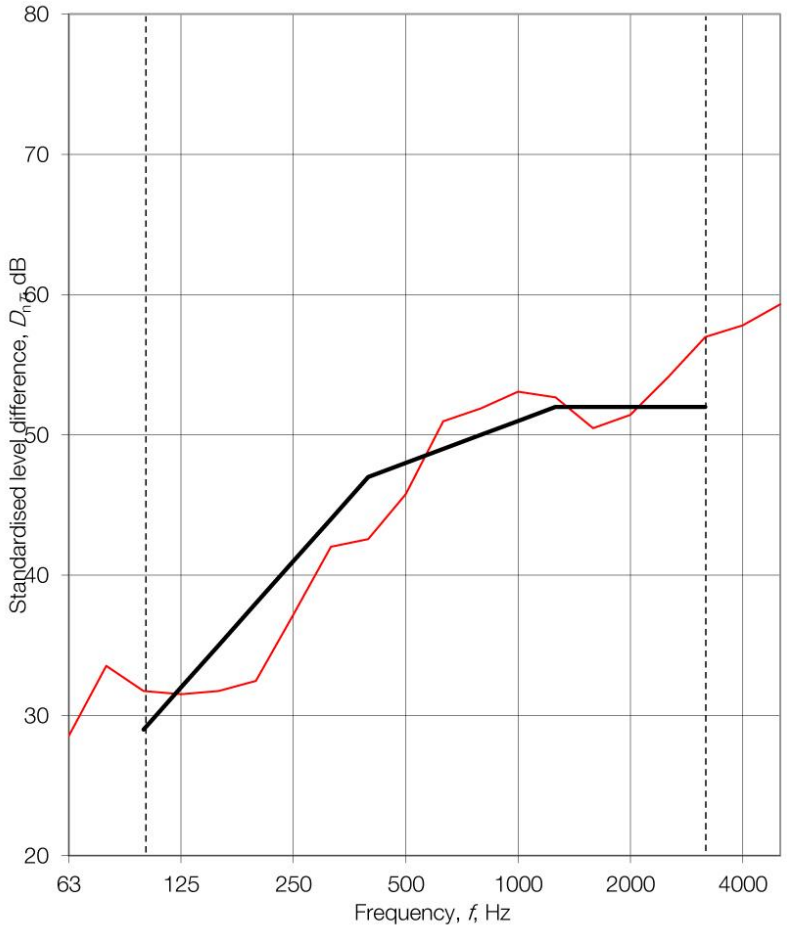
Description and identification of the building construction and test arrangement, direction of measurement:

Solid masonry original party wall

Source room volume: 279 m^3
Receiving room volume: 48 m^3

---- Frequency range according to the
—— curve of reference values (ISO 717-1)

Frequency f Hz	D_{nT} (1/3 octave) dB	
50	> 24.7	**
63	> 28.5	*
80	> 33.5	*
100	31.8	
125	31.5	
160	31.8	
200	32.5	
250	37.2	
315	> 42.0	**
400	42.6	
500	> 45.8	**
630	> 51.0	**
800	> 51.9	**
1000	> 53.1	**
1250	> 52.7	**
1600	50.5	
2000	51.4	
2500	54.1	
3150	> 57.0	*
4000	> 57.8	*
5000	> 59.3	*



Rating according to ISO 717-1

** measurement significantly affected by ambient / activity noise
* measurement partially affected by ambient / activity noise

$D_{nT,w}(C;C_{tr})$ = 48 (-1; -5) dB; $C_{50\text{-}3150}$= -2 dB; $C_{50\text{-}5000}$= -1 dB; $C_{100\text{-}5000}$= -1 dB

$C_{tr,50\text{-}3150}$= -7 dB; $C_{tr,50\text{-}5000}$= -7 dB; $C_{tr,100\text{-}5000}$= -5 dB

Evaluation based on field measurement results obtained by an engineering method

Test date:	13-Sep-23	Name of test institute:	Aether Acoustics
No. of test report:	AE0068		
Report date:	15-Sep-23	Signature:	

Appendix B

Calibration Certificates

Laboratory Location
Campbell Associates Ltd
5b Chelmsford Road Industrial Estate
GREAT DUNMOW, Essex, GB-CM6 1HD
Phone 01371 871030

CALIBRATION

Certificate of Calibration

Certificate number: **42147**

Test Object: **Sound Calibrator**

Producer: **Brüel & Kjær**
Type: **4231**
Serial number: **2292410**
Customer: **Aether Acoustics**
Address: **Inglistone, Lower St. Mary's Street, Newport, Pembrokeshire. SA42 0TS.**
Contact Person: **Stratton Barrett**
Order No: **N/A**

Measurement Results	Level dB	Level Stability dB	Frequency Hz	Distortion %
Measurement 1	114.05	0.02	999.97	0.43
Measurement 2	114.06	0.01	999.97	0.43
Measurement 3	114.06	0.02	999.97	0.43
Result (Average):	**114.06**	**0.02**	**999.97**	**0.43**
Expanded Uncertainty:	0.1	0.02	1	0.25
Degree of Freedom:	>100	>100	>100	>100
Coverage Factor:	2	2	2	2

The stated level is relative to 20µPa. The level is traceable to National Standards. The stated level is valid at reference conditions. The following correction factors have been applied during the measurement
Pres:0.0008 dB/kPa Temp:0.0015 dB/°C Humi:0.001 dB/%RH Load volume: 0.0003 dB/mm3

Conditions	*Pressure kPa*	*Temperature °C*	*Humidity %RH*
Reference conditions	101.325	23	50
Measurement conditions	101.164 ±0.042	21.9 ±0.1	50.4 ±1.3

The reported expanded uncertainty of measurements is based on a standard uncertainty multiplied by the coverage factor of k=2, providing a level of confidence of approximately 95%. Where the degrees of freedom are insufficient to maintain this confidence level, the coverage factor is increased to maintain this confidence level. The uncertainty has been determined in accordance with UKAS requirements.

Records: K:\C A\Calibration\Nor-1504\Nor-1018 CalCal\2022\BNK4231_2292410_M1.nmf

Preconditioning
The equipment was preconditioned for more than 4 hours in the specified calibration environment.

Method
Calibration has been performed as set out in the current version of CA Technical procedure TP01

Calibration Dates:

Received date:	30/09/2022	Reviewed date:	17/10/2022
Calibration date:	17/10/2022	Issued date:	17/10/2022

Technicians: (Electronic certificate)
Calibrated by: *Palaniwel Marappan B.Eng(Hons), M.Sc*
Reviewed by: *Jenny Crawford*

Doc ref: Calb-Cert-Master-V3-05

Certificate of Calibration

Continuation of Certificate number: **42147**

Reference Microphone: WSM8 - GRAS-40AG.147852

Measurements

The calibrator has been tested as described in the following annexes to BS EN IEC60942:2003 Sound Calibrators; B3.4 for sound pressure level, B3.5 for frequency, B3.6 for total distortion and A4.4 for short term stability of the pressure level.

Instruments and Program

A complete list of instruments, hardware and software that have been used for this calibration is available from the calibration laboratory

Comments

Primary level set to match associated SLM. Secondary level = 94.03dB. Note this is not UKAS data.

Traceability

The measured values are traceable to an accredited national physical laboratory within the EU or EFTA.

Notes:

The sound pressure level generated by the calibrator in its ½ inch configuration was measured five times and averaged by a WS2P working standard microphone for class 1 or 2 devices or a LS2P reference microphone for class 0 or LS devices as specified in the International Standard BS EN 61094-4. The results of three replications and the mean of the measurements obtained are given in the measurement results table of this certificate. The frequency and distortion were measured in a similar manner. The figures in BOLD are the final results; a small correction factor may need to be added to the sound pressure level quoted here if the device is used to calibrate a sound level meter that is fitted with a free field response microphone. See manufacturer's handbooks for full details of this and other corrections that may be applicable.

Observations:

This certificate relates only to the items tested above.

** End of Certificate **

Laboratory Location
Campbell Associates Ltd
5b Chelmsford Road Industrial Estate
GREAT DUNMOW, Essex, GB-CM6 1HD
Phone 01371 871030

CALIBRATION

Certificate of Calibration and Conformance

Certificate number: **42149**

Test Object: **Sound Level Meter, BS EN IEC 61672-1:2003 Class 1**

Producer: **Norsonic AS.**
Type: **140**
Serial number: **1405813**
Customer: **Aether Acoustics**
Address: **Inglistone, Lower St. Mary's Street, Newport, Pembrokeshire. SA42 0TS.**
Contact Person: **Stratton Barrett**
Order No: **N/A**

Introduction:
Calibration has been performed as set out in CA Technical Procedures which are based on the procedures for periodic verification of sound level meters as per the **Test Object** listed above. Results and conformance statement are overleaf and detailed results, where appropriate, are provided in the attached Measurement Report.

Tested:	*Producer*	*Type*	*Serial No*	*Certificate No*
Microphone	Norsonic	1225	208014	42148
Calibrator*	Brüel and Kjær	4231	2292410	42147
Preamplifier	Norsonic	1209	15652	Included

* The calibrator was complete with any required coupler for the microphone specified.

Additional items that have also been submitted for verification:

Wind shield	Norsonic	Nor1451 (ø 60mm)
Attenuator	N/A	
Extension cable	N/A	

These items have been taken into account wherever appropriate.

Instruction Manual: Im140_1Ed8R0En Firmware Version: v3.0.1866 The test object is a single channel instrument.

Conditions	*Pressure kPa*	*Temperature °C*	*Humidity %RH*
Reference conditions	101.325	23	50
Measurement conditions	101.20 ±0.02	21.90 ±0.1	51.28 ±1.05

Calibration Dates:

Received date:	30/09/2022	Reviewed date:	17/10/2022
Calibration date:	17/10/2022	Issued date:	17/10/2022

Technicians: (Electronic certificate)

Calibrated by: *Palanivel Marappan B.Eng (Hons), M.Sc*

Reviewed by: *Jenny Crawford*

Certificate of Calibration and Conformance

Continuation of Certificate number: **42149**

The statements of conformance and observation notes detailed in this certificate are made with reference to the following standards in respect of the calibration of the test object.

Manufactured:	**BS EN IEC 61672-1:2003**
Periodic Tests:	**BS EN IEC 61672-3:2006**
Pattern Evaluation:	**BS EN IEC 61672-2:2003**

Conformance:
From markings on the sound level meter or by reference to the manufacturer's published literature it has been determined that the instrument submitted for verification was originally manufactured to the listed standard and similarly that the associated sound calibrator conforms to the BS EN IEC 60942 standard.

Measurement Summary:

Indication at the calibration check frequency - IEC61672-3 Ed.1 #9	Passed
Self-generated noise - IEC 61672-3 Ed.1 #10.2	Passed
Acoustical signal tests of a frequency weighting - IEC 61672-3 Ed.1 #11	Passed
Electrical signal tests of frequency weightings - IEC 61672-3 Ed.1 #12	Passed
Frequency weightings: A Network - IEC 61672-3 Ed.1 #12.3	Passed
Frequency weightings: C Network - IEC 61672-3 Ed.1 #12.3	Passed
Frequency weightings: Z Network - IEC 61672-3 Ed.1 #12.3	Passed
Frequency and time weightings at 1 kHz IEC 61672-3 Ed.1 #13	Passed
Level linearity on the reference level range - IEC 61672-3 Ed.1 #14	Passed
Toneburst response - IEC 61672-3 Ed.1 #16	Passed
Peak C sound level - IEC 61672-3 Ed.1 #17	Passed
Overload indication - IEC 61672-3 Ed.1 #18	Passed

Comments
Correct level with associated calibrator is 113.9dB(A).

Statement of Conformance
The sound level meter submitted has successfully completed the periodic tests of the standard listed for the environmental conditions under which the tests were performed. As public evidence(1) was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with the manufacturer's standard to demonstrate that the model of sound level meter fully conformed to the requirements of the said standard, the sound level meter submitted for testing conforms to the relevant class of the said standard.
(1 - evidence is held on file at the calibration laboratory)

Observations
The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, providing a coverage probability of approximately 95 %. The uncertainty evaluation has been carried out in accordance with EA publication EA-4/02. Details of the uncertainty for each measurement are available from the Calibration Laboratory upon request. Details of the sources of corrections and their associated uncertainties that relate to this verification are contained within the test report accompanying this certificate.

This certificate relates only to the items tested above.

** End of Certificate **

Laboratory Location
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5b Chelmsford Road Industrial Estate
GREAT DUNMOW, Essex, GB-CM6 1HD
Phone 01371 871030

CALIBRATION

Certificate of Calibration

Certificate number: **42148**

Test Object: **Measurement Microphone**

Producer: **Norsonic AS.**
Type: **1225**
Serial number: **208014**
Customer: **Aether Acoustics**
Address: **Inglistone, Lower St. Mary's Street, Newport, Pembrokeshire. SA42 0TS.**
Contact Person: **Stratton Barrett**
Order No: **N/A**

Measurement Results	Sensitivity (dB re 1V/Pa)	Sensitivity (mV/Pa)	Capacitance (pF)
Measurement 1	*-25.41*	*53.65*	*22.92*
Measurement 2	*-25.41*	*53.66*	*23.03*
Measurement 3	*-25.41*	*53.62*	*23.02*
Result (Average):	***-25.41***	***53.64***	***22.99***
Expanded Uncertainty:	0.10		1.01
Degree of Freedom:	>100		>100
Coverage Factor:	2		2

The stated sensitivity is the pressure sensitivity at 250Hz, S_{250}, and is valid at reference conditions. The following correction factors have been applied during the measurement:
Pressure:uncertainty dB/kPa Temperature:-0.005 dB/°C Humidity:0 dB/%RH

Conditions	*Pressure kPa*	*Temperature °C*	*Humidty %RH*
Reference conditions	101.325	23	50
Measurement conditions	101.113 ± 0.044	22.1 ± 0.1	50.6 ± 1.7

The calibration test report shown on the next page gives details of the response at other frequencies relative to this 250 Hz reference sensitivity. Results ≥100 Hz are obtained using an electrostatic actuator as described in BS EN 61094-6 and those below 100 Hz are obtained in a reference pressure chamber. Detailed results are available from the calibration laboratory upon request.

The reported expanded uncertainty of measurements is based on a standard uncertainty multiplied by the coverage factor of k=2, providing a coverage probability of approximately 95%. Where the degrees of freedom are insufficient to maintain this confidence level, the coverage factor is increased to maintain this confidence level.

Calibration Dates:

Received date:	30/09/2022	Reviewed date:	17/10/2022
Calibration date:	17/10/2022	Issued date:	17/10/2022

Technicians: (Electronic certificate)
Calibrated by: *Palaniwel Marappan BEng(Hons), MSc*
Reviewed by: *Jenny Crawford*

Doc ref: Mic-Cert-Master-V3-04

Certificate of Calibration

Continuation of Certificate number: **42148**

Reference Calibrator: WSC1 - Nor1253-24269
Measurement Record: K:\C A\Calibration\Nor-1504\Nor-1017 MicCal\NOR1225_208014_M1.nmf

Preconditioning
The equipment was preconditioned for more than 12 hours at the specified calibration temperature and humidity.

Instruments and Program
A complete list of instruments, hardware and software that have been used for this calibration is available from the calibration laboratory

Traceability
The measured values for sound pressure, frequency, voltage, capacitance, temperature, humidity and ambient pressure are traceable to an accredited national physical laboratory.

Observations
The differences between the two results at 100 Hz are within normal limits bearing in mind the different test methods and are taken into account in arriving at the uncertainties of measurement.

Method of Calibration
The open circuit sensitivity of the microphone has been determined at 250 Hz against a reference laboratory standard measurement microphone by insert voltage techniques using a laboratory standard sound calibrator as a transfer standard. The electrostatic actuator frequency response was then obtained for frequencies above 100 Hz as described in BS EN IEC 61094-6. In addition, where requested the optional free field frequency response over the range 2 – 100 Hz has been obtained using a pressure chamber; in this case the reference frequency is 100 Hz. All of these results and their associated uncertainties are detailed in the table on page 3 of this certificate. See the observations field below for details of any discrepancies between the 100 Hz results obtained via the electrostatic actuator and pressure chamber.

The overall uncertainty at any frequency σCombined,Fn may be obtained by combining the uncertainty of the open circuit sensitivity σS250 with the uncertainty of the actuator / or LF pressure response at any other frequency σAct,Fn where Fn is the uncertainty at the frequency of interest using the relationship:

$$\sigma Combined,Fn = 2\sqrt{(\sigma 2S250 + \sigma 2ActFn)}$$

Appendix to this certificate
Where data is available from the microphone manufacturer to correct the actuator / pressure frequency response to obtain the random incidence and / or free field response it is shown in the appendix to this certificate. The uncertainty information relating to these corrections is the responsibility of the microphone manufacturer and when it is available the total uncertainty for the corrected frequency response at each point may then be obtained by including the correction uncertainty in the root-sum-square formula given above. These responses are outside the UKAS accredited scope, but are provided for information.

Observations