

Noise Impact Assessment

Environmental Noise Assessment
Proposed Hydro Power Scheme:
Plas Farm
Cilybebyll, Pontardawe
SWANSEA
SA8 3JQ

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1.0 Introduction

Aether Acoustics is appointed by Richard Bowen to carry out an assessment of environmental noise from a proposed 11kW hydroelectric power generation system.

This document provides an assessment of the potential noise impact from the proposal as relates nearby noise sensitive receptors (dwellings).

The turbine could operate continuously on demand and as such a day and night time noise assessment would be appropriate.

The acoustic assessment includes sections covering the following aspects:

- The results of a baseline noise survey in the vicinity of the nearest dwellings to the proposed turbine house.
- Criteria for acceptable noise levels inside and outside noise sensitive receptors, based on recognised guidance.
- Assessment of noise levels affecting the nearest dwellings in the context of recognised guidance.
- Recommendations on the potential noise impact of the system.

2.0 Baseline Noise Survey

2.1 Measurement Procedures

A baseline noise survey was undertaken by Stratton Barrett between 20:00 – 01:00 hours on 18th – 19th July 2024. Weather at the time of the survey was fine with low wind speeds (measured locally using a handheld anemometer at 2-5m/s). No rainfall was measured during the survey and as such all measurements were taken in fully dry conditions.

The meter was positioned at a representative location near a holiday home at Plas Farm (R1) and outside Cilybebyll Manor (R2).

The instrumentation used for the environmental noise survey consisted of a Norsonic NOR 140 Type 1 precision sound level meter and B&K 4231 calibrator. Laboratory calibration certificates are included at the end of this report.

The equipment was calibrated before and after the noise measurements. The sound level meter measured A-weighted (fast response) noise levels as well as octave band data. The measurement locations are shown in Figure 1 below (L1 & L2 marked in red).

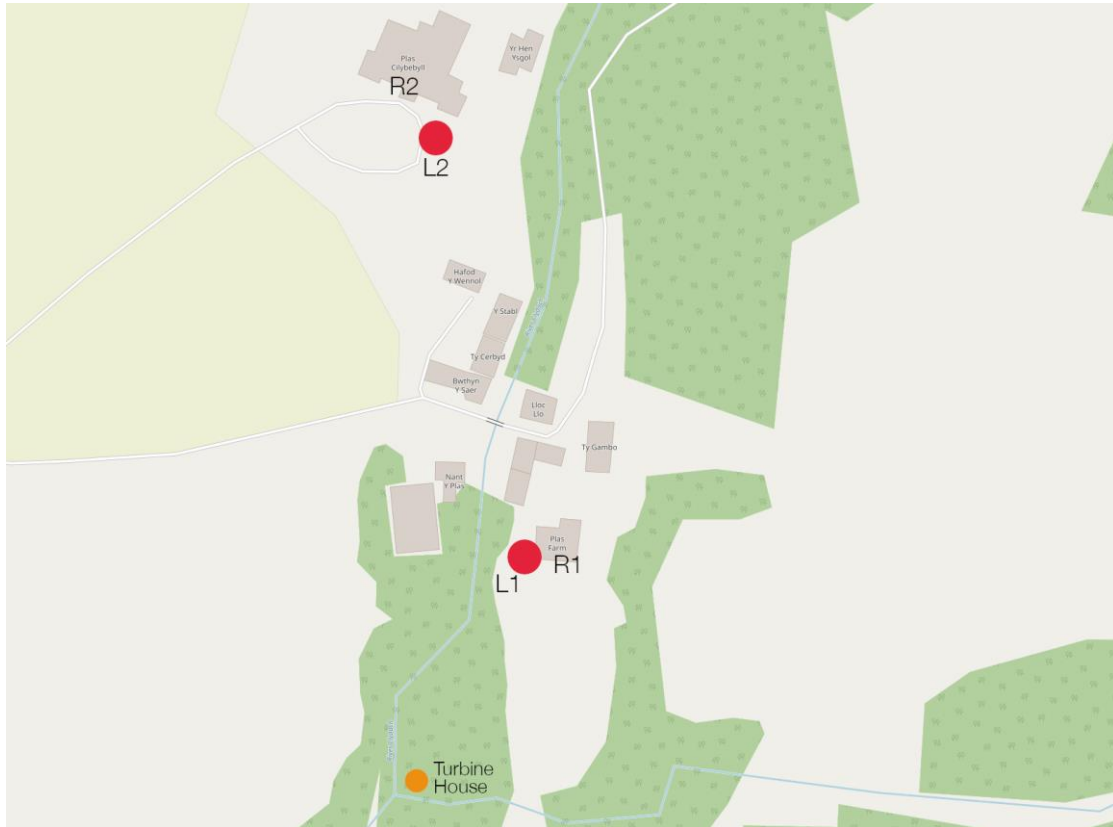


Figure 1: Open Street Map view, measurement locations and nearest receptors

2.2 Summary of Measured Ambient Noise Levels

Full results of the noise levels recorded by Aether Acoustics during the course of the noise survey are included in Appendix A of this report.

The following table summarises the results of the noise measurements in terms of averaged statistical noise levels.

Location	Period	Description	L _{AFmax}	L _{Aeq}	L _{A90}
L1	Daytime	Plas Farm (R1) @80m	61	44	43
L1	Night time	Plas Farm (R1) @80m	68	44	43
L2	Daytime	Gardens of Plas Cilybebyll (R2) @200m	59	39	37
L2	Night time	Gardens of Plas Cilybebyll (R2) @200m	62	37	36

Table 1: Summary of averaged noise measurement results (dBA)

2.3 Description of the Noise Climate

The noise climate at the survey location is dominated by the Clydach River, which runs through the property. The measured levels are generally constant for each period / location.

Noise from work activities on the farm would be expected to elevate the background sound level (BSL) periodically when underway.

2.4 Description of the Proposal

The proposal is understood to comprise of the following:

- A small intake structure across the watercourse on the face of a waterfall at Blaenant to the East of Plas Farm, incorporating a Coanda screen with 1.3mm apertures and stilling chamber.
- A pipeline of HDPE plastic pipe (200mm outside diameter) running from the intake down to a turbine house on the West side of the watercourse. The pipeline is 600m long and mainly buried.
- A wood clad turbine house building with a pitched roof, enclosing the hydroelectric turbine, generator, and control panel.
- A 10m long, 225mm diameter discharge pipe with a screen with 25mm spacing, and an outfall, in the form of a mortared stone cascade, to return water to the beck at the rear of the powerhouse.
- A buried electrical cable from the turbine enclosure to the Cilybebyll Manor connection point.

The proposed turbine house will be of solid masonry walls with timber cladding, a slate roof (uninsulated internally) and incorporating solid timber double doors (to North elevation) with acoustic threshold and perimeter seals. Any ventilation openings will be acoustically treated (not part of the scope of this assessment).

3.0 Noise Assessment Criteria

In order to assess the potential noise impact of the proposal, Aether Acoustics has reviewed the following guidance documents and standards:

- British Standard 8233: 2014
- World Health Organisation Guidelines on Community Noise
- British Standard 4142: 2014
- Planning Guidance Technical Advice Note (Wales) TAN 11

3.1 BS 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

3.2 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 an 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.

Section 4.3.1 of the document also defines reasonable outdoor noise limits with the aim of protecting outdoor amenity users from annoyance. In order to protect the majority of people from moderate annoyance, an outdoor limit of 50dB L_{Aeq} from steady, continuous noise is recommended.

3.3 BS 4142: 2014

British Standard 4142: 2014 “Methods for assessing and rating industrial and commercial sound” describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods described in this British Standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

- Typically, the greater this difference, the greater the magnitude of the impact.
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where 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.

BS 4142 notes that: Adverse impacts include, but are not limited to, annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact.

3.4 Planning Guidance TAN 11 (Wales)

TAN 11 guidance determines that the methodology detailed in British Standard 4142 (2014) should be used in assessing and specifying noise limits for new noise sources.

The Environmental Protection Act 1990 is also referenced, in which local authorities may serve abatement notices on those responsible for noise sources defined as a statutory nuisance.

3.5 Recommended Noise Criteria

Based on the guidance above, the following criteria would be recommended:

- A rating level not exceeding the existing BSL at the nearest residential receptor for any period, i.e. $\leq 36\text{dB}_{\text{LA90},15\text{mins}}$ (BS 4142: 2014).
- Noise levels inside any habitable room (on or off the Plas Farm site) should not exceed $30\text{dB}_{\text{LAeq},8\text{hr}}$ for night time periods (BS 8233: 2014).
- External noise levels should not exceed $50\text{dB}_{\text{LAeq},16\text{hr}}$ in outdoor amenity areas for daytime periods.

4.0 Noise Assessment

4.1 Background Sound Level

A statistical analysis of L_{A90} data suggests an evening and night time background sound level (BSL) of $43\text{dB}_{\text{LA90}}$ at Plas Farm and $36\text{dB}_{\text{LA90}}$ at Plas Cilybebyll.

The BSL is generally constant and would be dependent on the flow of the river running through the site; during the survey river noise was the dominant noise source and highly audible, having rained recently. In periods of minimal flow volume, noise from the river will likely be quieter, however it would be unlikely that the turbine would be operational in this case.

The BSL was not measured at the property located approx. 450m South of the proposed turbine (address to be confirmed). However, this property is also positioned close to the Clydach River and as such it would be expected that background sound levels will be similar to those at Plas Cilybebyll (approx. $36\text{dB}_{\text{LA90}}$).

4.2 Turbine Noise Levels

This section provides predictions of receiver incident noise levels at the nearest properties based on the turbine noise data provided.

A single figure (dBA) noise measurement value inside the turbine house of up to 86dBA (turbine running at full power) has been provided by the equipment supplier (no field measurement was possible). Octave band noise data was sought however this was unavailable.

It is calculated that an internal level of 86dBA would be attenuated to approx. 60-65dBA externally at 1m distance from the turbine house double doors. This would be a cautious estimate assuming small air gaps along door threshold etc.

Tables 3A – 3C below detail the predicted noise impact of the turbine at the nearest receptors.

Parameter (Night Time 15mins)	Location	Total dBA
Quoted internal noise level, turbine at full power	Inside turbine house	86
Immediately outside the turbine house (North elevation)	@1m from double doors	65
External Specific Level at NSR 1 (Plas Farm)	@80m	≤30
Measured Background Sound Level L_{A90}	Plas Farm	43
Specific Level compared with BSL		-13

Table 3A: Predicted night time external incident receptor level, Plas Farm

Parameter (Night Time 15mins)	Location	Total dBA
Quoted internal noise level, turbine at full power	Inside turbine house	86
Immediately outside the turbine house (North elevation)	@1m from double doors	65
External Specific Level at NSR 2 (Plas Cilybebyll)	@200m	≤22
Measured Background Sound Level L_{A90}	Plas Cilybebyll	36
Specific Level compared with BSL		-14

Table 3B: Predicted night time external incident receptor level, Plas Cilybebyll

Parameter (Night Time 15mins)	Location	Total dBA
Quoted internal noise level, turbine at full power	Inside turbine house	86
Immediately outside the turbine house (South elevation)	@1m from block work	≤60
External Specific Level at NSR 3 (Dwelling @450m South of turbine house)	@450m	≤15
Measured Background Sound Level L_{A90}	Dwelling to South of turbine	36
Specific Level compared with BSL (estimated)		-21

Table 3C: Predicted night time external incident receptor level, Dwelling 450m South

It has been calculated that noise break-out from the turbine house would result in a worst-case specific noise level approx. 30dB_{L_{Aeq,15mins}} at the nearest NSR. This would be approx. 13dB below the BSL.

An internal level approx. 15-18dBA could be expected inside habitable rooms at Plas Farm assuming partially open windows. This would be in compliance with the noise limits defined in BS 8233:2014 for bedrooms at night. Noise levels in habitable rooms at NSRs 2 & 3 would be significantly lower and as such would likely be inaudible.

The predicted receiver level of 30dBA would be in compliance with WHO guidance on acceptable noise levels in outdoor amenity areas (≤ 50 dBA).

4.3 Turbine Rating Level (BS 4142)

British Standard 4142 methodology includes the potential for penalty corrections when assessing a noise source, to account for impulsivity, intermittency and tonal characteristics. The document states:

Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, add a character correction to the specific sound level to obtain the rating level.

A correction of up to +9dB can be applied for impulsivity of a source. In this instance, it will be likely that noise from the turbine will be generally constant without distinguishable impulsivity.

A correction of +3dB can be applied where the intermittency of the source is readily distinctive against the residual acoustic environment. It would be unlikely that any intermittency in the running of the turbine would be over a short enough time period to be readily distinctive and as such no penalty would be recommended.

No data is available for octave band noise levels from the turbine and as such it is not possible to analyse potential tonality in this case. It may be that the unit exhibits some tonal characteristics in the low – mid frequency bands (a rumbling or humming character) and as such a penalty of +2dB may be deemed appropriate (just perceptible at the receptor).

Table 5 below provides a summary of rating level parameters according to BS 4142:2014.

Receptor	Min. Distance	Specific Level at Receptor $L_{Aeq,T}$	Appropriate Penalty			Rating Level	Rating compared with BSL
			Impulsivity	Intermittency	Tonality		
NSR 1	80m	≤ 30 dB	0	0	2	32dB	-11dB
NSR 2	200m	≤ 22 dB	0	0	2	24dB	-12dB
NSR 3	450m	≤ 15 dB	0	0	2	17dB	-19dB

Table 5: Summary of potential noise impact compared with the measured BSL

It can be seen that the rating levels at all NSRs would be significantly below the BSL for day and night time periods.

4.4 Other Potential Noise Sources

Other potential noise sources associated with the installation would be limited to water movement (inlet / outlet); no other mechanical items would be proposed.

Water movement over the proposed intake screen (at Blaen-nant) would not be expected to create significant turbulence and as such would be highly unlikely to elevate cumulative noise levels from the river as relates receptors at this location.

Likewise, the stone cascade outfall at Plas Farm would provide insufficient turbulence to create any significant additional water flow noise, and as such will have no effect on NSRs.

5.0 Conclusions

Aether Acoustics has undertaken a noise impact assessment for the proposed hydro scheme at Plas Farm.

The assessment makes the following conclusions:

- Background sound levels were measured in the vicinity of the proposal; the noise climate is dominated by the river and as such is generally constant (day and night time, dependent on flow volume).
- The proposed turbine house will be of a substantial construction and any egress paths (e.g. ventilation penetrations) will be fitted with acoustic attenuation, door seals etc. in line with good practice.
- Noise levels inside the turbine house have been estimated at approx. 86dBA (full power). This would equate to a worst-case receptor level approx. 30dBA at Plas Farm (32dB Rating Level). This would be at least 11dB below the prevailing BSL and as such would be very unlikely to present the potential for adverse noise impact.
- Internal noise levels <18dBA could be expected from the turbine at the nearest NSR, which would be 12dBA better than good design criteria described in BS 8233:2014.
- The applicant owns Plas Farm and Plas Cilybebyll; the nearest third-party receptor is at a distance of approx. 450m, whereat a noise level of 15dBA or less would be predicted, i.e. unlikely to be audible outside.
- Any water redirection / outflow associated with the proposal would have negligible effects on river noise in general at each location.
- The proposal would be in compliance with guidance discussed in Section 3 of this report and in line with the recommended criteria detailed in Section 3.5.

Appendix A

Full Results of Noise Survey

RTC	Duration	Location	L _{Aeq}	L _A F _{max}	L _{A10}	L _{A90}
(2024/07/18 20:24:19.00)	(0:0:16.0)	CAL	94.0	94.0	94.0	93.8
(2024/07/18 20:26:17.00)	(0:5:0.0)	1	43.9	49.7	45.1	43.5
(2024/07/18 20:31:19.00)	(0:5:0.0)	1	44.3	57.1	49.1	43.5
(2024/07/18 20:36:21.00)	(0:5:0.0)	1	44.4	58.2	50.6	43.5
(2024/07/18 20:41:23.00)	(0:5:0.0)	1	43.9	47.6	45.2	43.5
(2024/07/18 20:46:25.00)	(0:5:0.0)	1	43.8	47.3	45.3	43.4
(2024/07/18 20:51:27.00)	(0:5:0.0)	1	43.8	47.8	44.9	43.5
(2024/07/18 20:56:30.00)	(0:5:0.0)	1	44.1	60.7	47.0	43.5
(2024/07/18 21:01:32.00)	(0:1:46.0)	1	44.4	51.9	49.1	43.6
(2024/07/18 21:07:00.00)	(0:5:0.0)	2	38.0	53.0	43.7	37.0
(2024/07/18 21:12:03.00)	(0:5:0.0)	2	40.3	56.5	51.0	37.0
(2024/07/18 21:17:05.00)	(0:5:0.0)	2	39.1	51.1	45.1	37.2
(2024/07/18 21:22:07.00)	(0:5:0.0)	2	40.5	56.0	50.3	37.0
(2024/07/18 21:27:09.00)	(0:5:0.0)	2	41.7	57.1	51.7	37.2
(2024/07/18 21:32:11.00)	(0:5:0.0)	2	38.1	48.0	42.9	37.3
(2024/07/18 21:37:13.00)	(0:5:0.0)	2	37.8	58.5	39.4	37.1
(2024/07/18 21:42:15.00)	(0:5:0.0)	2	37.8	48.3	41.5	37.1
(2024/07/18 21:47:18.00)	(0:5:0.0)	2	37.7	49.2	39.9	37.1
(2024/07/18 21:52:20.00)	(0:5:0.0)	2	37.4	44.5	40.4	36.9
(2024/07/18 21:57:22.00)	(0:5:0.0)	2	37.4	41.2	39.4	37.0
(2024/07/18 22:02:24.00)	(0:5:0.0)	2	38.3	50.6	46.2	37.1
(2024/07/18 22:07:26.00)	(0:5:0.0)	2	37.4	43.8	38.2	37.1
(2024/07/18 22:12:28.00)	(0:5:0.0)	2	37.5	43.7	40.8	37.0
(2024/07/18 22:17:31.00)	(0:5:0.0)	2	37.5	39.1	38.3	37.1
(2024/07/18 22:22:33.00)	(0:2:56.0)	2	37.8	46.6	41.0	37.4
(2024/07/18 22:30:11.00)	(0:5:0.0)	1	43.7	50.3	44.4	43.3
(2024/07/18 22:35:13.00)	(0:5:0.0)	1	43.7	44.6	44.2	43.4
(2024/07/18 22:40:15.00)	(0:5:0.0)	1	43.7	44.6	44.3	43.4
(2024/07/18 22:45:17.00)	(0:5:0.0)	1	43.7	44.9	44.3	43.4
(2024/07/18 22:50:20.00)	(0:5:0.0)	1	43.8	49.8	45.7	43.4
(2024/07/18 22:55:22.00)	(0:5:0.0)	1	43.7	44.7	44.3	43.4
(2024/07/18 23:00:24.00)	(0:5:0.0)	1	43.7	44.8	44.3	43.4
(2024/07/18 23:05:26.00)	(0:5:0.0)	1	43.7	44.7	44.3	43.4
(2024/07/18 23:10:29.00)	(0:5:0.0)	1	43.7	45.3	44.3	43.4
(2024/07/18 23:15:31.00)	(0:5:0.0)	1	43.7	48.6	44.4	43.4
(2024/07/18 23:20:33.00)	(0:5:0.0)	1	43.8	45.2	44.4	43.4
(2024/07/18 23:25:36.00)	(0:5:0.0)	1	43.8	44.6	44.3	43.5
(2024/07/18 23:30:38.00)	(0:5:0.0)	1	43.8	47.6	44.9	43.5
(2024/07/18 23:35:40.00)	(0:5:0.0)	1	43.8	44.9	44.4	43.5
(2024/07/18 23:40:42.00)	(0:5:0.0)	1	44.3	68.4	44.5	43.5
(2024/07/18 23:45:44.00)	(0:2:6.0)	1	44.3	62.2	47.3	43.4
(2024/07/18 23:52:04.00)	(0:5:0.0)	2	37.7	62.0	40.7	36.0
(2024/07/18 23:57:06.00)	(0:5:0.0)	2	36.4	38.0	37.2	36.1
(2024/07/19 00:02:08.00)	(0:5:0.0)	2	36.6	41.4	38.9	36.1

(2024/07/19 00:07:10.00)	(0:5:0.0)	2	36.3	37.9	37.0	36.0
(2024/07/19 00:12:12.00)	(0:5:0.0)	2	36.2	38.3	37.4	36.0
(2024/07/19 00:17:14.00)	(0:5:0.0)	2	36.3	38.0	37.4	36.0
(2024/07/19 00:22:17.00)	(0:5:0.0)	2	36.3	37.7	36.9	36.1
(2024/07/19 00:27:18.00)	(0:5:0.0)	2	36.4	38.0	37.3	36.1
(2024/07/19 00:32:20.00)	(0:5:0.0)	2	36.4	37.9	37.4	36.1
(2024/07/19 00:37:22.00)	(0:5:0.0)	2	36.3	37.2	36.8	36.1
(2024/07/19 00:42:24.00)	(0:5:0.0)	2	36.3	37.4	37.0	36.0
(2024/07/19 00:47:26.00)	(0:5:0.0)	2	36.3	38.4	37.3	36.0
(2024/07/19 00:52:29.00)	(0:5:0.0)	2	36.3	37.6	36.8	36.1
(2024/07/19 00:57:31.00)	(0:5:0.0)	2	38.0	55.9	45.4	36.1
(2024/07/19 01:02:18.00)	(0:0:19.0)	CAL	94.1	94.0	94.0	93.9

Appendix A: Full results of noise measurements at Plas Farm, 18th July 2024

Appendix B

Calibration Certificates

Laboratory Location

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



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*

This certificate is issued in accordance with the CA Quality Management system. It provides traceability of measurement to recognized national standards, and to the units of measurement realized at the National Physical Laboratory or other recognized national standards laboratories. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

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 - IEC 61672-3 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

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



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, S₂₅₀, 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	Humidity %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: *Palanivel Marappan BEng(Hons), MSc*
 Reviewed by: *Jenny Crawford*

This certificate is issued in accordance with the CA Quality Management system. It provides traceability of measurement to recognized national standards, and to the units of measurement realized at the National Physical Laboratory or other recognized national standards laboratories. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

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 $\sigma_{\text{Combined},Fn}$ may be obtained by combining the uncertainty of the open circuit sensitivity σ_{S250} with the uncertainty of the actuator / or LF pressure response at any other frequency $\sigma_{\text{Act},Fn}$ where Fn is the uncertainty at the frequency of interest using the relationship:

$$\sigma_{\text{Combined},Fn} = 2\sqrt{(\sigma_{S250}^2 + \sigma_{\text{Act},Fn}^2)}$$

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

Certificate of Calibration

CERTIFICATE OF CALIBRATION

ISSUED BY Gracey & Associates BSI CERTIFICATE FS 25913
DATE OF ISSUE 12 March 2024 CERTIFICATE NUMBER 2024-0313
DATE OF CALIBRATION 12 March 2024
CALIBRATION INTERVAL 12 months PAGE 1 OF 2



Gracey & Associates
Barn Court Shelton Road
Upper Dean PE28 0NQ
Tel: 01234 708835
www.gracey.co.uk

TEST ENGINEER APPROVING SIGNATORY
Jamie Bishop Greg Rice

Equipment **B&K 4231, s/n: 2292410**
Description Calibrator - Acoustic - Class 1, Hottinger Brüel & Kjær UK Ltd
Customer Aether Acoustics
Inglistone, Lower St Mary's Street, Newport, SA42 0TS

Standards
BS EN 60942

Conditions
Atmospheric Pressure 100.1 kPa
Temperature 22.0 °C
Relative Humidity 36.4 %

Calibration Data

Output Level 94.1 dB
Frequency 1000.0 Hz

Calibration Reference Sources

Equipment	S/N	Equipment	S/N
B&K 4134 L	1935995	Druck DPI 141	479
HP 34401	3146A16728	Nor 1253	22456
Stanford DS36	33213	Vaisala HMP23	S2430007

Notes

We certify that the above product was duly tested and found to be within the specification at the points measured (except where indicated). Measurements are traceable to reference sources calibrated to National Standards. Where no national or international standards exist, traceability is to standards maintained by the manufacturer. Our Quality Management System has been assessed to comply with BS EN ISO 9001:2015 - BSI Certificate number FS 25913. Tests were carried out in environmental conditions controlled to the extent appropriate to the instrument's specification. All relevant test certificates are available for inspection. The uncertainties are for a confidence probability of not less than 95%.
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Hire and calibration of noise and vibration instruments under a BSI ISO 9001 quality management system, Cert No. FS 25913.