



Noise Monitoring and Assessment

in support of discharging permit condition IC33

30 June 2022

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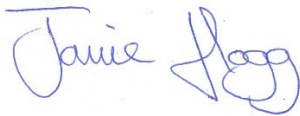
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Noise Monitoring and Assessment

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Name Jamie Hogg
Job title Senior Acoustic Consultant



Name David Pollok
Job title Partner

[Double click to insert signature]



Name Michael Fraser
Job title Technical Director

Name
Job title

Environmental Resources Management Ltd
2nd Floor
Exchequer Court
33 St Mary Axe
London
EC3A 8AA

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Acronyms and Abbreviations

Name	Description
NRW	Natural Resources Wales
ERM	Environmental Resources Management Limited
WHO	World Health Organisation
dB	dB stands for decibel, a logarithmic measure of the sound level.
dB(A)	dB(A) denotes a single number sound pressure level that includes a frequency weighting (“A-weighting”) to reflect the subjective loudness of the sound level. The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).
L _{Aeq}	The L _{Aeq} level gives a single figure to describe a sound that varies over a given time period, T. It is the A-weighted steady sound level that would result in the same sound energy at the receiver as occurred in practice with the varying level. It is derived from the logarithmic summation of the sound signal and so unlike a conventional (linear) average it gives additional weighting to higher levels.
L _w or SWL	Sound Power Level. This is a measure of the total sound power radiated by a source. The Sound Power of a source is a fundamental property of the source and is independent of the surrounding environment.
L _{A90}	Background Noise Level. Background noise level is a measure of the low level of noise that occurs between the higher levels from particular events, for example passing vehicles. This may be abbreviated to BNL and the symbol is LA90. It is the value exceeded for 90% of the time period being considered. Note that it is higher than the minimum noise level but may be regarded as the typical noise level during ‘quiet periods’.
L _{Amax,f}	Maximum Noise Level. The L _{Amax,f} is the highest value of the sound level over the specified period. It is sometimes referred to as ‘peak’ noise level. However, the term ‘peak’ has a special meaning in acoustics and the expression ‘maximum’ is preferable to avoid confusion. The ‘f’ stands for fast response.
FFT	Fast Fourier Transform. An algorithm which converts a signal into individual spectral components and thereby provides frequency information about the signal.
kHz	Kilohertz. A measure of frequency.
m/s	Metres per second. A measure of speed.
PO1/PO2	NRW permit pre-operating conditions 1 and 2.
IC33	NRW permit improvement condition 33.
NIA	Noise and Vibration Impact Assessment report B01. An assessment of noise and vibration carried out in 2016/17 which formed part of Valero’s planning and permit applications for the Cogen project.

1. SUMMARY

Valero Energy Ltd (Valero) has installed a combined heat and power (CHP) plant or cogeneration plant (referred to hereafter as the Project or the Cogen)

As required by permit improvement condition IC33, noise monitoring and an assessment according to BS 4142 has been carried out to assess the significance of noise impacts from the Cogen at the only occupied residential property in Rhoscrowther; 1 Pleasant View.

The results of the noise monitoring show that noise from the Cogen is slightly quieter than predicted in the NIA.

Previous noise monitoring of the background sound level, carried out for pre-operating condition PO2 showed the representative background sound level is slightly higher than reported in the NIA.

As a consequence of these two factors, the difference between the background sound level and noise from the Cogen (the 'initial assessment' value according to BS 4142), is less than was predicted in the NIA.

However, a degree of tonality was measured from the Cogen, which was not anticipated in the NIA. This attracts a penalty correction, increasing the initial assessment value, although it remains 4 – 5 dB lower than predicted in the NIA.

Following the initial assessment, a number of factors relevant to the context of noise from the Project are considered (as required by the BS 4142 method). Each suggests the significance of noise effects would be lower than the initial estimate. One factor considered was a five day period where the Cogen was switched off for maintenance, which appeared to make little difference to the measured sound levels.

Taking account of the context, noise effects from the Project at 1 Pleasant View are not expected to be significant. This confirms the conclusions of the NIA.

2. BACKGROUND

Valero Energy Ltd (Valero) has installed a combined heat and power (CHP) plant or cogeneration plant (referred to hereafter as the Project or the Cogen), to meet the electrical power and supplement steam demands of their Pembroke Refinery (the Refinery). The Refinery is located immediately to the north of the hamlet of Rhoscrowther, approximately 8 km west of the town of Pembroke.

The regulating authority for the Refinery's environmental permit, Natural Resources Wales (NRW), granted a variation to the Refinery's permit to include the Project in October 2017 (permit number EPR/YP3930EX). The varied permit includes pre-operating and improvement conditions related to noise from the Project (PO1, PO2 and IC33).

The status of the pre-operating conditions is as follows:

- PO1 required a written proposal for enhancing the background sound measurements included in the original permit application. A noise monitoring proposal was developed which was accepted by NRW in November 2017, effectively discharging this condition.
- PO2 required Valero to carry out the baseline noise monitoring set out in PO1 and submit the results to NRW in the form of a written report. The scope of the baseline noise monitoring consisted of four seasonal surveys undertaken over a period of approximately one year between autumn 2017 and summer 2018. The four reports that accompanied the surveys were submitted to NRW, with a final 'whole year' report detailing the overall results of the exercise submitted in December 2020.

The requirements of IC33 are set out below, in Box 1.

Box 1 : IC33 Requirements

Table S1.3 Improvement programme requirements		
Reference	Requirement	Date
IC33	<p>If residential property at 1 Pleasant View in Rhoscrowther is occupied at the start of operation, then following successful commissioning and establishment of routine steady operation, the operator shall undertake noise monitoring to confirm the conclusions of the application Noise and Vibration Impact Assessment report B01. This shall include:</p> <ul style="list-style-type: none"> • A full noise monitoring survey and assessment meeting BS4142:2014 standard • Narrow band (FFT) measurements to identify and any tonal elements or low frequency noise • Reference to the World Health Organisation guidelines for community noise and night noise <p>Upon completion of the work, a written report shall be submitted to Natural Resources Wales. The report shall refer to the predictions in the Noise and Vibration Impact Assessment report B01. If rating levels are expected to result in a significant impact in context at sensitive receptors, in an assessment in accordance with BS4142, then the report shall include an assessment of suitable abatement techniques, an estimate of the costs, the expected decibel reduction and a proposed timetable for their installation.</p>	Within 6 months of the completion of commissioning

1 Pleasant View was occupied at the start of operation. Therefore the monitoring and assessment work required by IC33 has been carried out. This document sets out the results of this noise monitoring and assessment work. The remainder of this document is set out as follows:

- Section 2 provides an overview of the assessment process required by IC33;
- Section 3 presents the results of the noise monitoring survey used to quantify noise from the Cogen; and
- Section 4 presents the results of the assessment of noise from the Cogen, according to BS 4142.

3. OVERVIEW OF THE ASSESSMENT PROCESS REQUIRED BY IC33

3.1 Terminology

IC33 requires noise monitoring and assessment according to BS 4142:2014¹. BS 4142 defines several terms which are referred to in this document. They are listed below.

- Specific sound level, L_s ($L_{Aeq,Tr}$). The sound level of the noise source being assessed.
- Rating level, $L_{Ar,Tr}$. The specific sound level plus any adjustment for characteristic features of the sound.
- Ambient sound, L_a ($L_{Aeq,T}$). The overall sound level from all sources, usually composed of sound from many sources near and far.
- Residual sound level, L_r ($L_{Aeq,T}$). The sound level remaining when the specific sound level is sufficiently suppressed so as not to contribute to the ambient sound level.
- Background sound level ($L_{A90,T}$). The L_{90} statistical measure of the residual sound level. The background sound level is an underlying level of sound over a period, T . It does not reflect the occurrence of transient and/or higher sound level events and is generally governed by continuous or semi-continuous sounds.

3.2 BS 4142 Assessment

3.2.1 Initial Assessment

BS 4142 includes an assessment of the difference between the background sound level and the rating level at the receptor. This is referred to as the ‘initial assessment’.

As described above, the rating level is equal to the specific sound level plus any adjustment for characteristic features of the sound.

The background sound level was quantified through several successive rounds of noise monitoring required by PO2. Details are provided in the PO2 ‘whole year’ baseline noise monitoring report². Noise monitoring has been carried out to quantify the specific sound level and the rating level. This is discussed below in Section 0.

Table 1 summarises the initial estimate of noise impacts for increasing differences between the background sound level and the rating level at the receptor.

Table 1: BS 4142 Initial Estimate of Noise Impacts

Noise Rating level, $L_{Ar,Tr}$	BS 4142 Extract Regarding the Initial Assessment
<= background + 5dB	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.
> background + 5dB	A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.

¹ BS 4142:2014 Methods for Rating and Assessing Industrial and Commercial Sound, British Standards Institute

² Issued to NRW by email (to Gary Evans) on the 23rd December 2020.

up to background + 10dB	
> background + 10dB	A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context

3.2.2 Consideration of Context

Following the initial assessment, BS 4142 requires consideration of the context in which the sound occurs when determining the significance of the impact. BS 4142 states:

The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs. An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context.

Where the initial estimate of the impact needs to be modified due to the context, various pertinent factors need to be considered, including the following:

- The absolute level of sound. IC33 requires the assessment to make reference to the World Health Organisation (WHO) Guidelines for Community Noise and night noise. These documents provide guidelines on health effects in terms of absolute sound levels. Although these guidance documents are not UK noise standards, BS 4142 makes reference to BS 8233³ in relation to benchmark noise criteria for residential properties, which in turn makes reference to the WHO guidelines.
- The character and level of the residual sound compared to the character and level of the specific sound.
- The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions.

3.3 Noise Abatement

If the assessment concludes that a significant impact in context exists, in accordance with BS 4142, then the report should include an assessment of suitable abatement techniques, an estimate of the costs, the expected decibel reduction and a proposed timetable for their installation. As this report concludes that no significant impact in context exists, no abatement techniques are suggested.

³ BS 8233. Guidance on sound insulation and noise reduction for buildings. BSI 2014.

4. NOISE MONITORING AND ANALYSIS OF RESULTS

4.1 Introduction

In order to discharge IC33, noise monitoring has been carried out to inform an assessment of noise at 1 Pleasant View, Rhoscrowther, the only occupied residential property in Rhoscrowther. Full details of the noise monitoring results are provided in Appendix A.

4.2 Monitoring Method

4.2.1 Monitoring Period

Noise monitoring was carried out between 25th January and 3rd May 2022. The noise monitoring equipment developed a fault and did not monitor noise for 13 days between 24th February and 9th March. Excluding this period, monitoring was carried out for a total of 85 days.

The Cogen was shut down for a period of 5 days, for annual maintenance, between 27th March and 1st April. Noise monitoring continued throughout this period. This allowed the effect of switching the Cogen off and on, to be measured directly and is discussed further in Section 4.5.1.

4.2.2 Monitoring Equipment and Data Recorded

Monitoring was carried out using a Rion NL-52 Class 1 sound level meter (SLM) and a Lufft WS600 weather station. A Rion WS-15 enhanced windshield was used on the SLM which features a large diameter windshield and a discrete secondary layer to minimise wind effects at the microphone.

The microphone was installed at a height approximately 1.5 m above the ground, and the system was located in free-field conditions (ie at least 3.5 m from the nearest hard reflective surface).

The sound level meter was calibrated before the survey. Following the survey, the calibration level was checked. No significant drift (ie > 0.5 dB) was noted. A copy of the SLM calibration certificates is appended in Appendix C.

Sound levels were logged continuously over the survey period. Standard metrics including L_{Aeq} , L_{A90} and $L_{Amax,f}$ were recorded over 15 minute intervals. In addition, meteorological data such as precipitation, wind speed and direction were continuously logged at one minute intervals.

To minimise the influence on the measurements from sources of interference such as wind passing over the diaphragm of the microphone or rain falling on the microphone windshield, measurements made during rainfall events and wind speeds of greater than 5 m/s were discarded during data analysis. This follows the guidance given in BS 4142. The highest one minute average wind speed recorded during each 15 minute noise measurement period was used to decide whether to discard noise measurements. Wind directions were derived by averaging the one minute wind direction values for each 15 minute noise measurement.

In addition, high quality (uncompressed 16 bit, 48 kHz) one minute audio samples were recorded every hour, to inform an assessment of tonality.

4.2.3 Monitoring Location

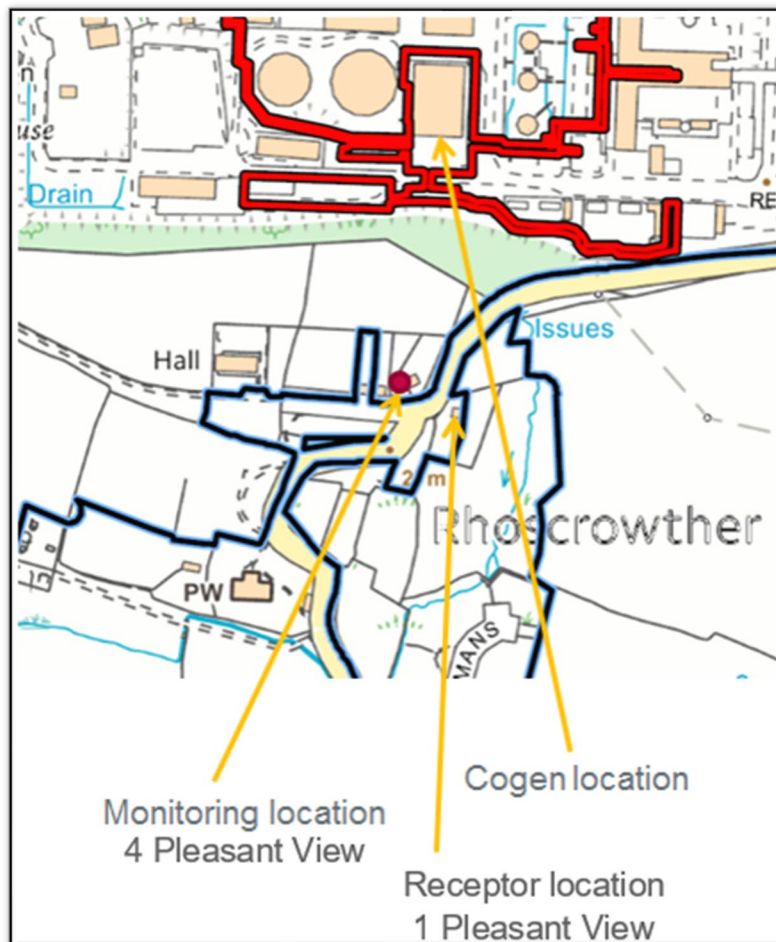
In line with the PO2 baseline monitoring, 4 Pleasant View was chosen as a representative location to carry out the noise monitoring. BS 4142 states with regard to the measurement location:

“Choose outdoor measurement locations that will give results that are representative of the ambient sound and residual sound at the assessment location(s). Make the measurement of the ambient sound level, the residual sound level and the background sound level at a height of 1.2 m to 1.5 m above the ground, unless there is a specific reason to use an alternative height (which should be justified)”.

4 Pleasant View has been chosen as a representative location for the following reasons:

- it is a consistent location providing continuity with the baseline noise monitoring carried out for PO2, enabling a like-for-like comparison when comparing the lower end of the measured sound levels between the two surveys;
- it is considered likely to be reasonably representative of the specific sound level at 1 Pleasant View, for the reasons listed below;
 - The two locations are situated near each other (~ 50 m apart) and at a similar distance from the Cogen (see Figure 1). Therefore, noise levels from the Cogen are likely to be similar, although 4 Pleasant View is located slightly closer (120 m vs 145 m), so noise levels here may be slightly higher, which would be conservative.
 - Using the planning/permit application noise model, noise from the Cogen at the two locations is predicted to be within 0.5 dB.
- it has a free-field location within the garden to the rear available for monitoring; and
- it is within Valero's ownership and is therefore readily accessible and secure.

Figure 1: Receptor and Proposed Monitoring Location



4.3 Approach to Quantifying the Specific Sound Level

Monitoring sound levels at the receptor captures not only noise from the Cogen itself (the specific sound level), but also from other sources (the residual sound level), mainly from the rest of the Refinery.

The sound level from the rest of the Refinery can be variable. Therefore in order to quantify the specific sound level, L_s ($L_{Aeq,Tr}$), the following approach has been used.

- Set up a logging sound level meter at a representative receptor location, to log 15 minute sound levels continuously for a long period (approximately 12 weeks).
- Use these data to estimate noise from the Cogen (the specific sound level), by comparing the lower end of the measured sound levels, $L_{Aeq,15mins}$, with those captured during the PO2 baseline monitoring. Noise from the Cogen will be quantified as the uplift in the lower end of measured sound levels between these two surveys.

The Cogen was switched off during the survey for a period of 5 days, for maintenance. During this time, on-site engineers noted that noise from the unit (and the process of servicing it) was not significant. This allowed the effect of switching the Cogen off and on to be measured directly. The measurements of the unit operating and switched off showed little difference in sound level (see

Figure 8 Figure 9 in Appendix A). This is a positive indication that the Cogen does not contribute significantly to ambient noise levels and has been taken into account when considering the significance of the impact in Section 5. However, because the difference between the ambient and residual sound level was small, the measurements could not reliably be used to quantify the specific sound level directly (hence the method outlined above has been used).

4.4 Approach to Quantifying the Rating Level

As described above, the rating level is equal to the specific sound level plus any adjustment for characteristic features of the sound. BS 4142 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.

The following acoustic features are described in the standard:

- tonality: up to a +6 dB penalty;
- impulsivity: up to a +9 dB penalty (this can be summed with the tonality penalty);
- intermittency: a +3 dB penalty; and
- other sound characteristics (neither tonal nor impulsive but still distinctive): a +3 dB penalty.

IC33 requires the use of “Narrow band (FFT) measurements to identify and any tonal elements or low frequency noise”. Therefore, the reference method⁴ for assessing the audibility of tones set out in BS 4142 has been used. This is discussed further in Section 4.5.2. The reference method makes use of FFT measurements to assess the prominence of tones in the same way as listeners do on average. It includes procedures to identify low-frequency tones.

The presence of other acoustic features were assessed by the surveyor (an experienced acoustician), whilst on-site. Attended measurements made at the representative receptor location showed no impulsivity using the objective method from BS 4142, Appendix E.

No intermittency or other sound characteristics were audible at the representative receptor location and therefore no corrections have been made to the specific sound level to account for these acoustic features.

⁴ BS 4142, Appendix D: Objective method for assessing the audibility of tones in sound: Reference method.

4.5 Noise Monitoring Results

This section presents a summary of the results of the noise monitoring, including the derived specific sound level and rating level.

4.5.1 Specific Sound Level

As discussed in Section 4.3, the specific sound level (noise from the Cogen) has been estimated as the uplift in the lower end of measured sound levels, $L_{Aeq,15mins}$, when compared with those captured during the PO2 baseline monitoring survey.

The lowest sound level values from the PO2 and IC33 surveys have been adopted and are presented below in Table 2. The lowest values have been adopted for the following reasons:

- For the IC33 survey, the lowest sound level value occurs frequently (see Table 2). The distribution of measurement values appears to have been truncated at the lower end which indicates a steady noise. This is shown in Figure 2. If the sound level measurements followed a Normal Distribution or 'bell curve', the number of measurements at high and low extremes would taper off gradually to zero. A tapering off can be seen at the high end of measured levels only. This may be due to an uplift in noise as a result of the Cogen. However, as little difference in sound levels was evident when the Cogen was switched off (albeit over a limited period), it may be due to other sources within the refinery. If this were the case, making use of this sound level value would be conservative as the Cogen would therefore be producing a lower sound level.
- There is little change to this value for different wind directions; it increases by less than 0.5 dB for the most common wind directions making up ~70% of the survey and by less than 1 dB for wind directions making up more than 90% of the survey. The PO2 sound levels tend to also increase by a similar amount for the different wind directions.
- The lowest $L_{Aeq,15mins}$ measurement from the PO2 survey has also been adopted to be conservative (using a lower value here results in a higher calculated specific sound level).

The specific sound level is the ambient sound level minus the residual sound level⁵ and its calculated value is also presented in Table 2.

Table 2: Specific Sound Level

	Lowest Measured Sound Level, $L_{Aeq,15mins}$ dB	Number of Occurrences During Survey ⁽¹⁾
Lower end of residual sound level (2)	43.2	5
Lower end of ambient sound level (3)	49.6	86
Specific sound level ⁽⁴⁾	48.5	-

1) Number of occurrences of the measured sound level value, when rounded to zero decimal places.

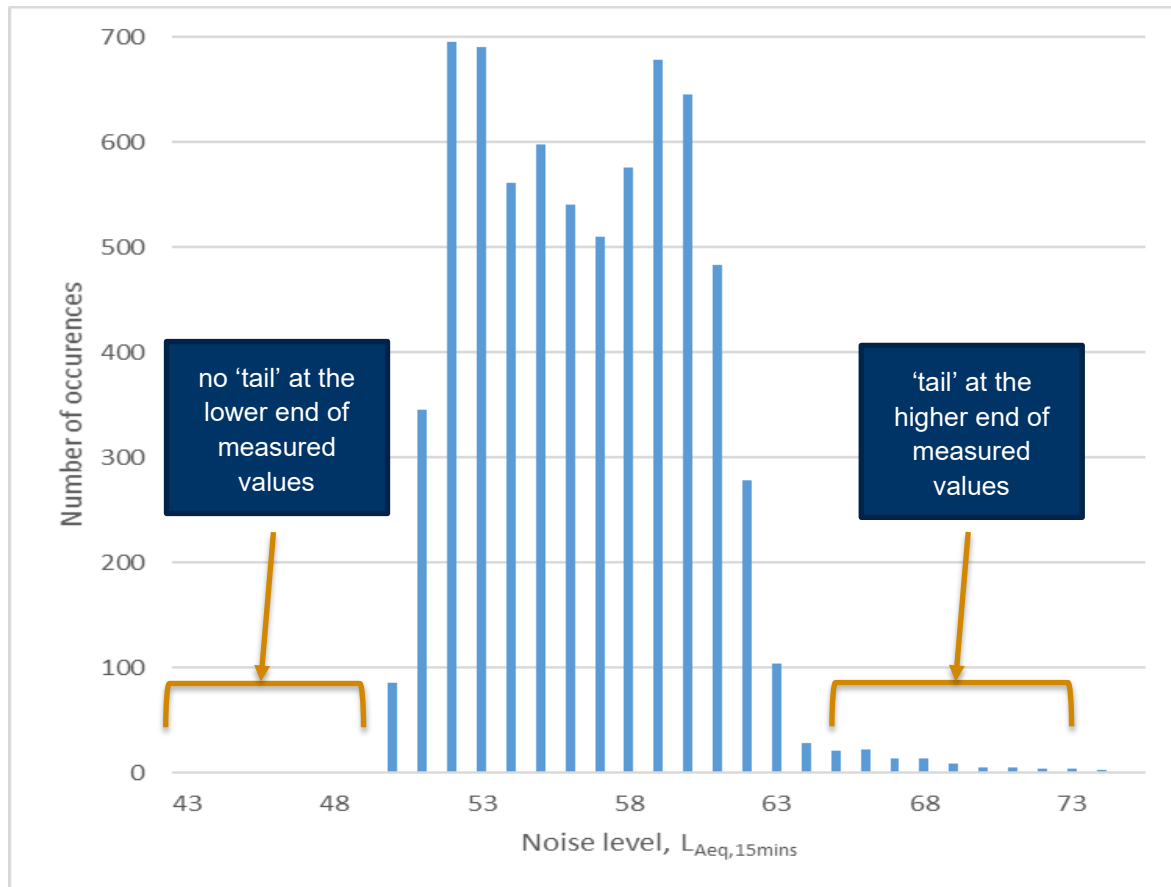
2) Lowest $L_{Aeq,15mins}$ measurements from the PO2 baseline survey which is assumed to represent the residual sound level.

3) Lowest $L_{Aeq,15mins}$ measurements from the IC33 noise monitoring survey. Assumed to represent the typical sound level when it is likely to be dominated by Cogen and other extraneous noise sources are minimised (for the purpose of the BS 4142 assessment, this is called the ambient sound level).

4) Calculated from the residual sound level and the ambient sound level.

⁵ As decibels are a logarithmic unit of measurement, the calculation is carried out logarithmically.

Figure 2: Distribution of Measured Noise Levels



4.5.2 Assessment of the Audibility of Tones

High quality (uncompressed 16 bit, 48 kHz) one minute audio samples were recorded every hour during the monitoring survey, to inform an assessment of tonality. This assessment has followed the 'Objective method for assessing the audibility of tones in sound: Reference method' set out in BS 4142. The computer software package AS-70, by Rion, was used in carrying out the assessment.

The purpose of the tonality assessment is to assess the prominence of tones in the same way as listeners do on average. The assessment calculates the following:

- A tonal audibility value. Tonal audibility, ΔL_{ta} is expressed in dB above the masking threshold (MT), a value that is related to the masking noise level (L_{pn}).
- A tonality 'adjustment', K_t of between 0 and 6 dB. The adjustment, K_t is zero for tonal audibility values of less than 4 dB.

A number of points in time were assessed, spaced over the survey period. Normally, audio samples during the night were used. This time of day was chosen with the aim of minimising noise from birds and local human activity.

The results, in terms of tonal audibility, ΔL_{ta} and Adjustment value, K_t are presented in Appendix B. Where tones were detected in the critical band, their frequencies have been included.

4.5.3 Rating Level

As discussed in Section 4.4, no intermittency or other sound characteristics were audible at the representative receptor location and therefore no corrections have been made to the specific sound level to account for these acoustic features.

An assessment of the audibility of tones was carried out using audio recordings which were logged throughout the survey as well as during attended measurements carried out at the representative receptor location during a two day site visit to set up the noise logging equipment. Details of the method used are provided in Section 4.5.2.

The results show that a detectable tone was normally present at 100 Hz, but varied in audibility and resulting acoustic feature correction.

In terms of the small number of attended measurements taken during the two day site visit; on the first day, three measurements were made between 15:08 and 15:41 which resulted in acoustic feature corrections ranging between 1 dB and 6 dB. On the second day, four measurements were made between 09:58 and 14:13 all of which resulted in an acoustic feature correction of 0 dB.

Measurements were carried out on-site to investigate the likely source of the tonality. Measurements made close to the Cogen plant (between 10 m and 30 m), resulted in acoustic feature corrections at 100 Hz ranging between 2 dB and 6 dB.

37 audio recordings carried out over the survey period whilst the Cogen was operational have been assessed (see Appendix B for detailed results). The resulting tonal audibility varied, resulting in an acoustic feature correction ranging between 0 dB and 4.4 dB.

Audio recordings made during the 5 day period when the Cogen was switched off for maintenance were assessed. A total of 47 audio recordings were assessed. Only one showed a tone at 100 Hz, with a resulting correction of 0 dB.

Although some uncertainty remains due to the proximity of other significant noise sources, it appears likely that the Cogen produces a tone, normally at 100 Hz, but with varying audibility which is normally not high enough to attract an acoustic feature correction. In order to determine an appropriate 'typical' adjustment value for the assessment, the higher of the modal value and the 80th percentile has been adopted. This results in an adopted adjustment value of 1.4 dB (the 80th percentile).

5. BS 4142 ASSESSMENT

5.1 Introduction

This section reports the results of an assessment of noise from the Cogen according to BS 4142. The assessment process is outlined in Section 3. This section is set out as follows:

- Initial assessment
- Consideration of context and assessment of significance
- Consideration of uncertainty

5.2 Initial Assessment

The initial assessment considers the difference between the background sound level and the rating level at the receptor.

The rating level is equal to the specific sound level plus any adjustment for characteristic features of the sound. The specific sound level and rating level have been derived by measurement, as detailed in Section 4.5.

The background sound level was quantified through several successive rounds of noise monitoring required by PO2. Details are provided in the PO2 ‘whole year’ baseline noise monitoring report⁶.

Table 3 summarises these values and presents the initial assessment of impacts, in accordance with BS 4142. As no clear correlation was noted between noise level and the time of day, or day of the week, for either the background sound level or specific sound level, a single value representing a 24 hour period is presented.

Table 3: Initial Estimate of Noise Impacts

Metric	Sound Level, dB(A)
Representative background sound level, $L_{90,15mins}$	48
Specific sound level, $L_s (L_{Aeq,Tr})$	48.5
Acoustic feature correction	1.4
Rating level, $L_{Ar,Tr}$	49.9
Exceedance of Rating Level over Representative Background Sound Level	1.9

BS 4142 states that “*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.*”

For reference, an exceedance of rating level over representative background sound level of 6 dB during the day and 7 dB at night was predicted in the NIA. Further details are presented in Table 4.

⁶ Issued to NRW by email (to Gary Evans) on the 23rd December 2020.

Table 4: Comparison of Initial Assessment Results with Those Presented in the NIA

Metric	Sound Level, dB(A)		
	IC33 ⁽¹⁾	NIA ⁽²⁾	
		24h Period	Day
Representative background sound level, L ₉₀ ,15mins	48	46	45
Specific sound level, L _s (L _{Aeq,Tr})	48.5	52	52
Acoustic feature correction	1.4	0	0
Rating level, L _{Ar,Tr}	49.9	52	52
Exceedance of Rating Level over Representative Background Sound Level	1.9	6	7

1) Specific sound level based on measurement. Representative background sound level based on PO2 noise monitoring.

2) Based on a predicted specific sound level and background noise monitoring carried out for the NIA.

5.3 Consideration of Context and Assessment of Significance

This section considers the context in which the sound occurs, as required by BS 4142. Many of the pertinent factors are the same as those presented in the NIA.

- Background sound levels are often higher than the representative background sound level. For more than half of the time the exceedance of rating level over background sound level is predicted to be less than 5 dB, ie below the threshold for an adverse impact.
- There is just one occupied residential property in Rhoscrowther, at 1 Pleasant View.
- Noise from the Project would have an industrial character which would be in common with the existing noise environment. This should lessen its perceived impact.
- The main garden of No. 1 Pleasant View is situated to the south of the house and the area of the garden directly south of the house will therefore be screened from Project noise by the house. Predictions carried out here for the NIA gave a level of 39 dB, L_{Aeq}, which should result in a good external amenity. As the measured specific sound level (noise from the Cogen) is lower than the specific level (facing the site) predicted in the NIA (see Table 4), a good external amenity at this location would still be expected in the garden.
- No complaints regarding noise have been received from the one occupied residential property in Rhoscrowther since the Cogen was installed.
- The Cogen was switched off during the survey for a period of 5 days, for maintenance. During this time, on-site engineers noted that noise from the unit and the maintenance of it was not significant. This allowed the effect of switching the Cogen off and on to be measured directly. The measurements of the unit operating and switched off showed little difference in recorded sound level. This is a positive indication that the Cogen does not contribute significantly to ambient noise levels.

A number of factors are relevant to the context of noise from the Project in Rhoscrowther. Each one suggests the significance of noise effects would be lower than the initial estimate set out in Table 3. Therefore, taken together, the significance of noise effects is expected to be significantly lower.

Taking account of the context, noise effects from the Project are not expected to be significant. This confirms the conclusions of the NIA.

5.4 Uncertainty

A long monitoring duration of approximately 12 weeks was undertaken to reduce uncertainty in measured sound levels. Despite this, uncertainties can arise, including those listed below, which have been discussed in the relevant sections of this report.

- Choice of representative monitoring location.
- Choice of residual and ambient noise level values from the PO2 and IC33 surveys, used to calculate the specific sound level.

Where there are uncertainties, a conservative approach has been taken in general (e.g. where the level of tonality was found to vary, the 80th percentile value was used to represent a typical value).

As the measured rating level is 4 – 5 dB below the rating level predicted in the NIA, it is considered unlikely that the uncertainties inherent in this assessment would be sufficient to affect its conclusion.

APPENDIX A NOISE MONITORING RESULTS

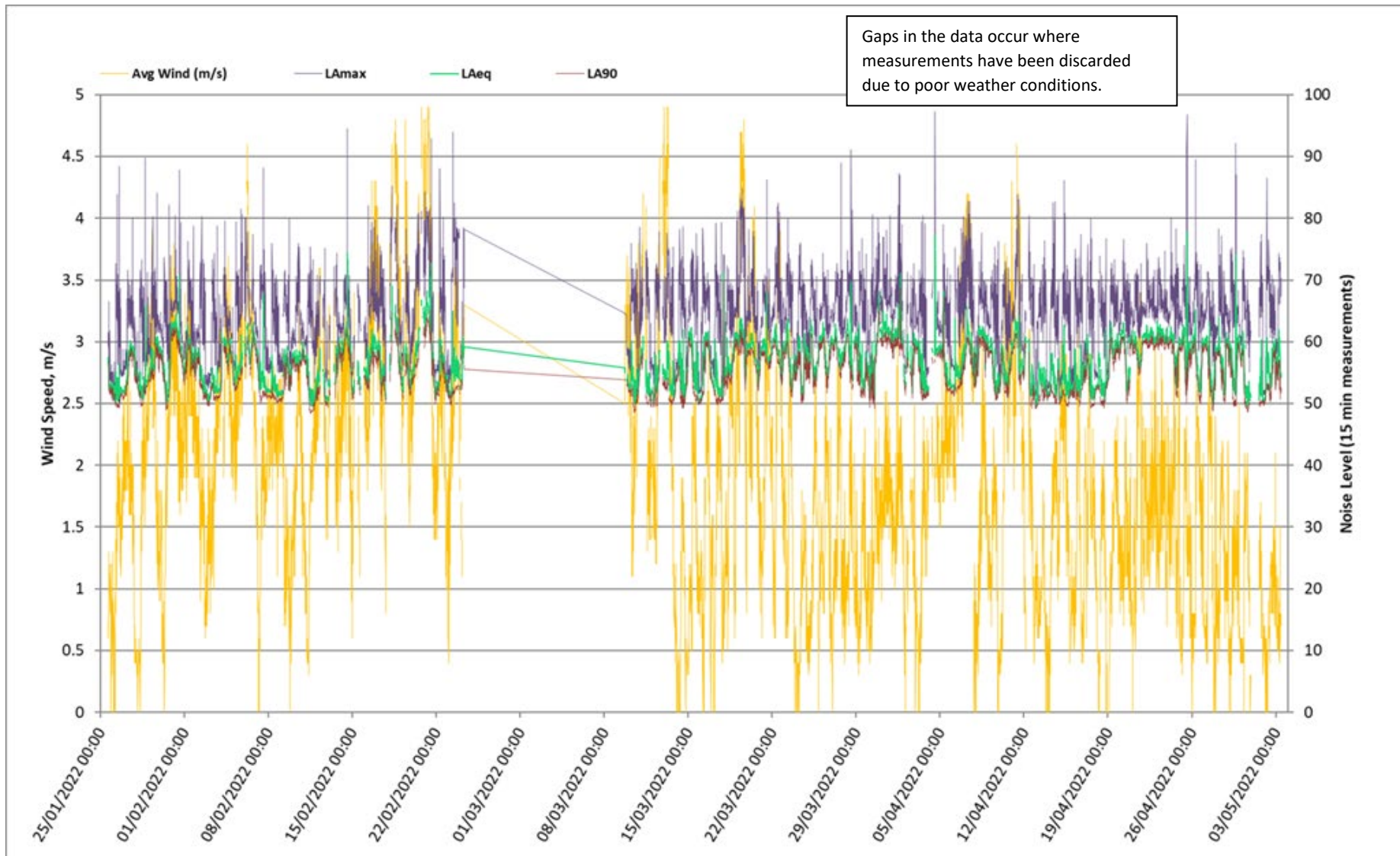
The results of the noise monitoring survey are presented in this appendix.

Survey Data

Of the 8,100 15 minute measurements recorded during the survey, after discarding data as a result of poor weather conditions, a total of 7,377 (91%) remain.

Figure 3 presents the 15 minute sound levels measured during the survey along with corresponding wind speed measurements.

Figure 3: Sound Level and Wind Speed Measurements



Effect of Wind Direction

Figure 4 presents the range of 15 minute L_{Aeq} sound levels measured under each wind direction during the survey.

Figure 4: Range of $L_{Aeq,15min}$ Sound Level Measured for each Wind Direction

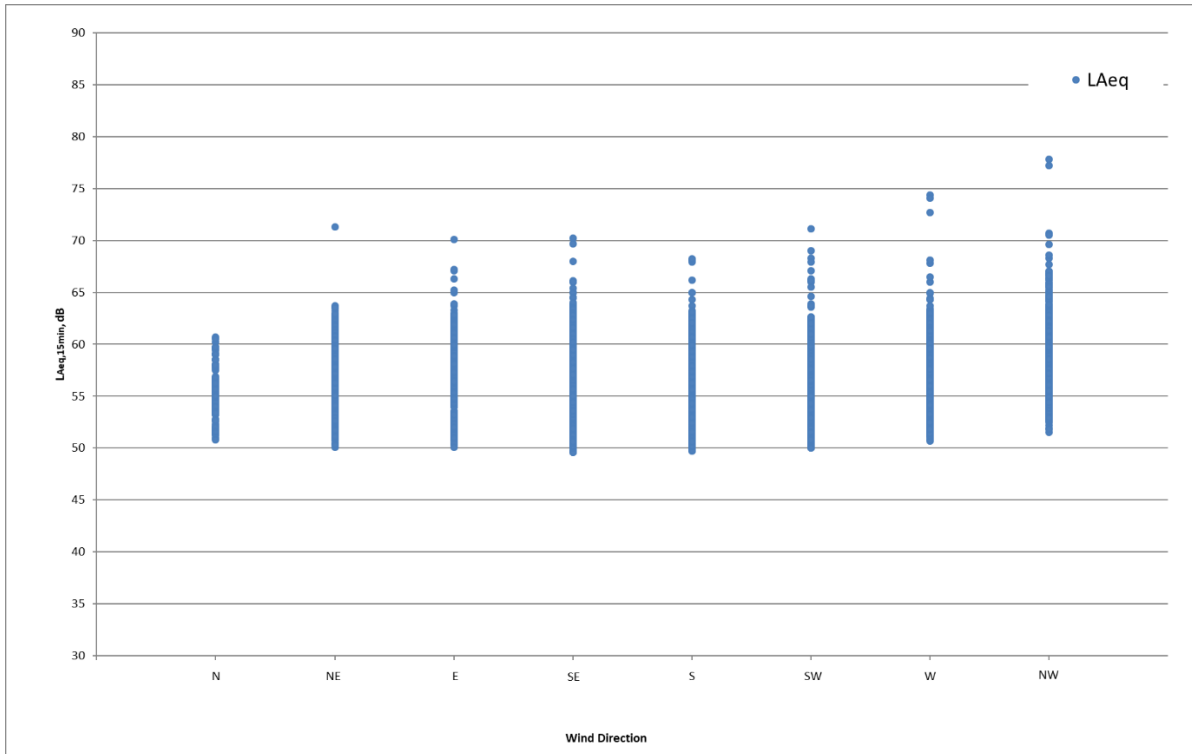
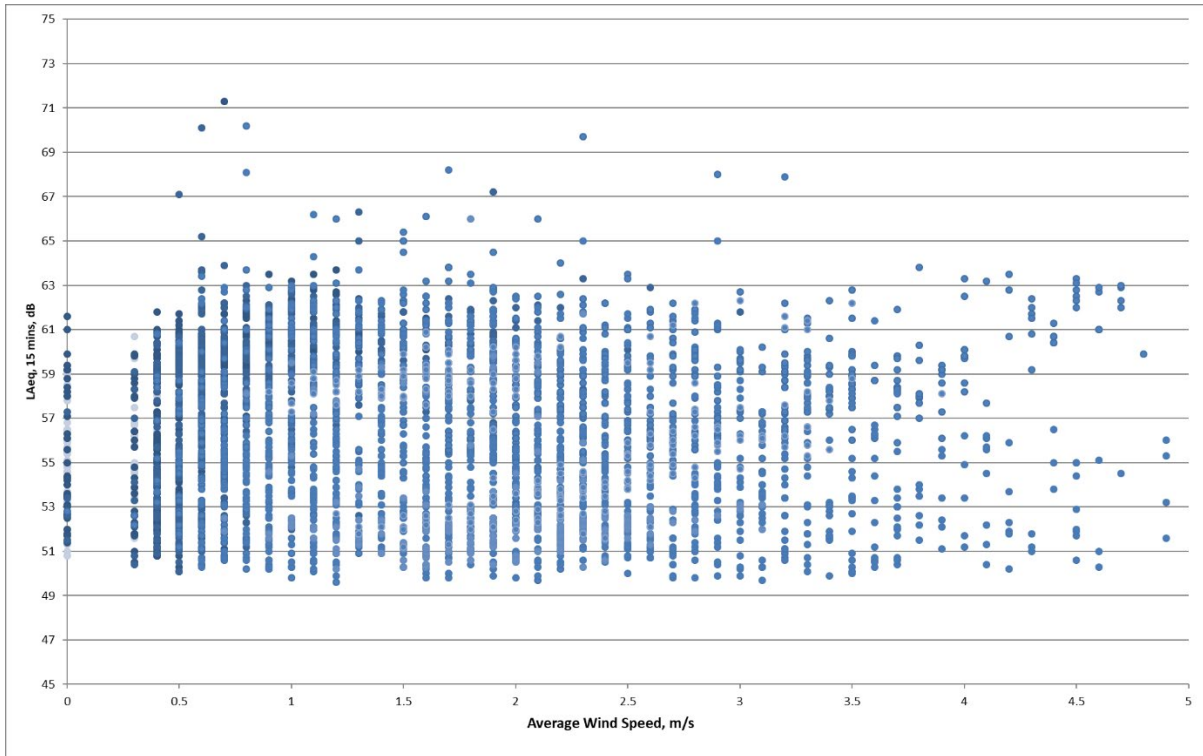


Figure 4 shows little clear correlation between wind direction and measured sound level. A smaller range is evident during northerly winds, however, less wind from this direction was experienced during the survey resulting in a small sample size.

Effect of Wind Speed

Figure 5 presents L_{Aeq} sound levels against average wind speeds measured during the survey.

Figure 5: $L_{Aeq,15min}$ Range of Sound Levels Measured at Different Wind Speeds



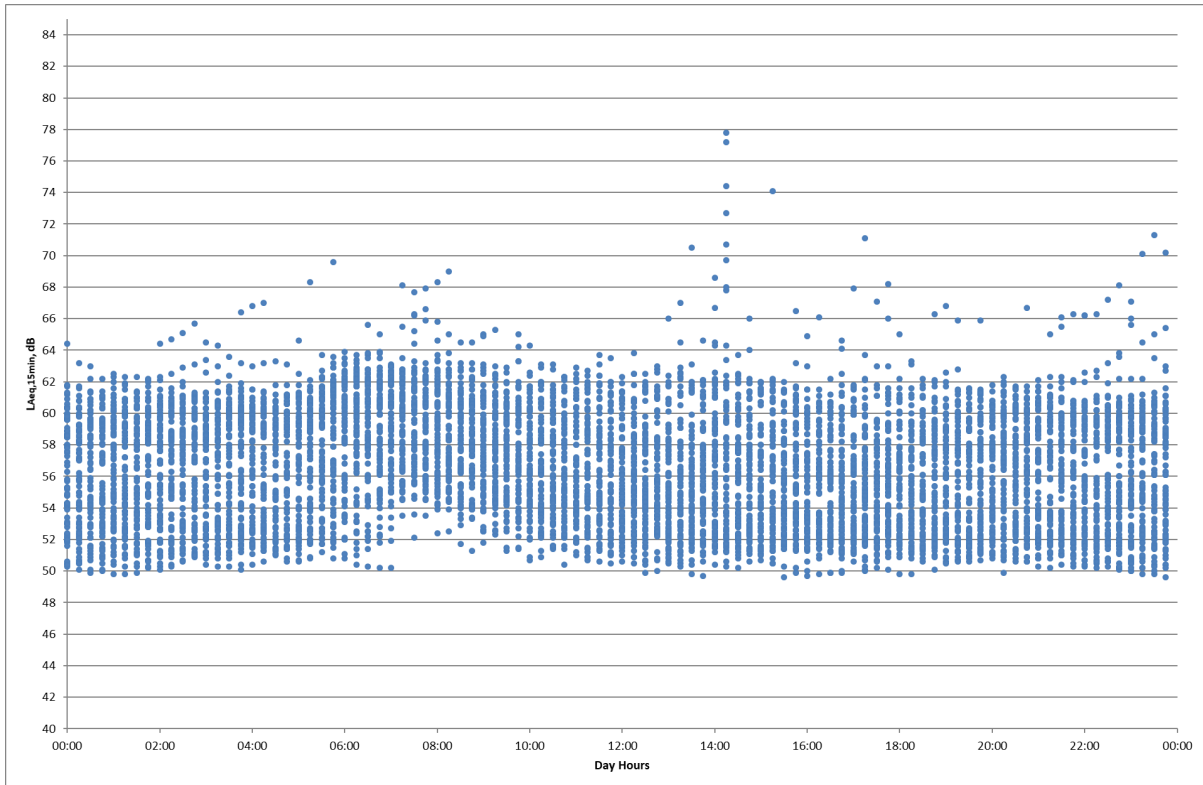
No clear correlation is evident between wind speed and measured sound level.

Diurnal Variation

This section considers whether sound levels are consistently higher or lower at different times of the day.

Figure 6 shows the range of $L_{Aeq,15min}$ levels measured throughout the day. There is little evidence of diurnal variation.

Figure 6: $L_{Aeq,15min}$ Sound Level Variation Over the Day



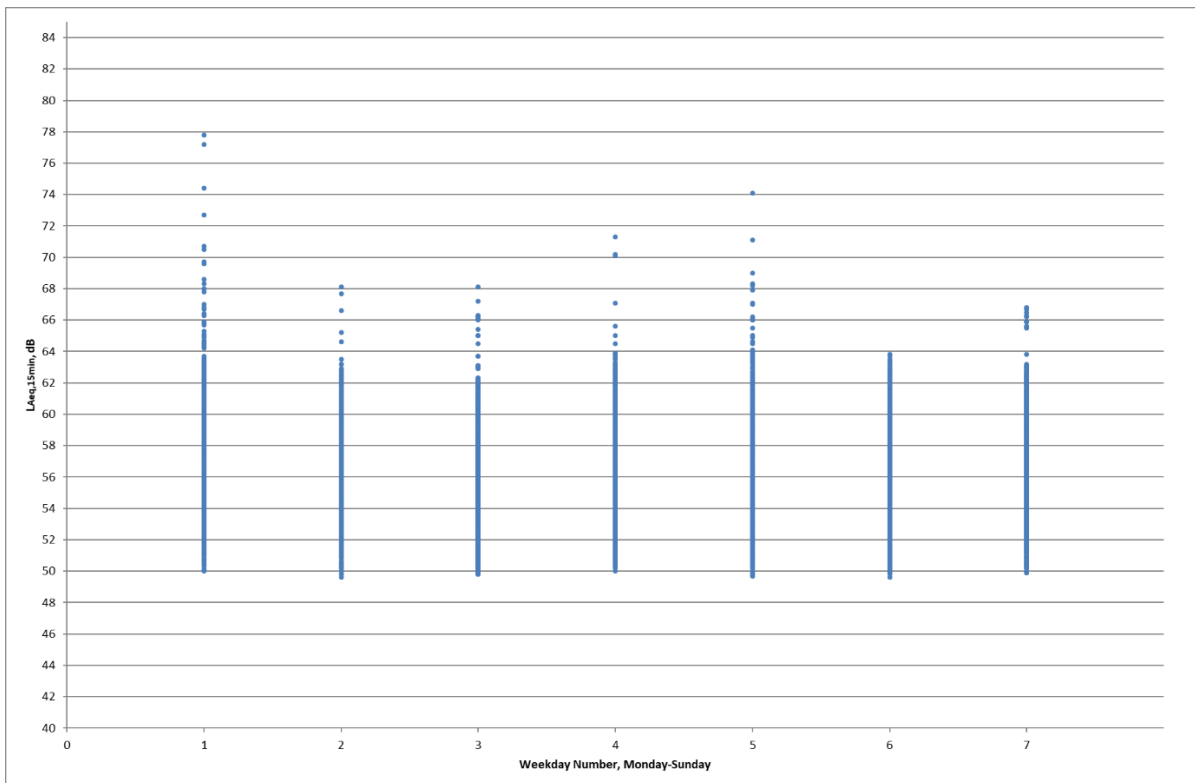
Daily Variation

This section considers whether sound levels are consistently higher or lower on different days of the week.

Figure 7 presents the range of 15 minute L_{Aeq} sound levels measured on each day of the week.

On Monday, Friday and Sunday, sound levels several decibels higher than other days of the week were measured. However, little difference in the lower end of sound levels is apparent.

Figure 7: $L_{Aeq,15min}$ Sound Level Daily Variation



Measurements of Cogen Operating and Not

The Cogen was switched off for a period of 5 days during the survey, for an annual maintenance service, as follows:

- 27th March, ~09.30; Cogen shut down.
- 1st April, ~16:00; Cogen switched back on again.

Figure 8 shows measured noise data for the entire survey period, highlighting the period when the unit was switched off. Figure 9 shows data for a shorter period either side of the maintenance event.

Figure 8: Entire Survey Period, Cogen Shutdown Highlighted in Red

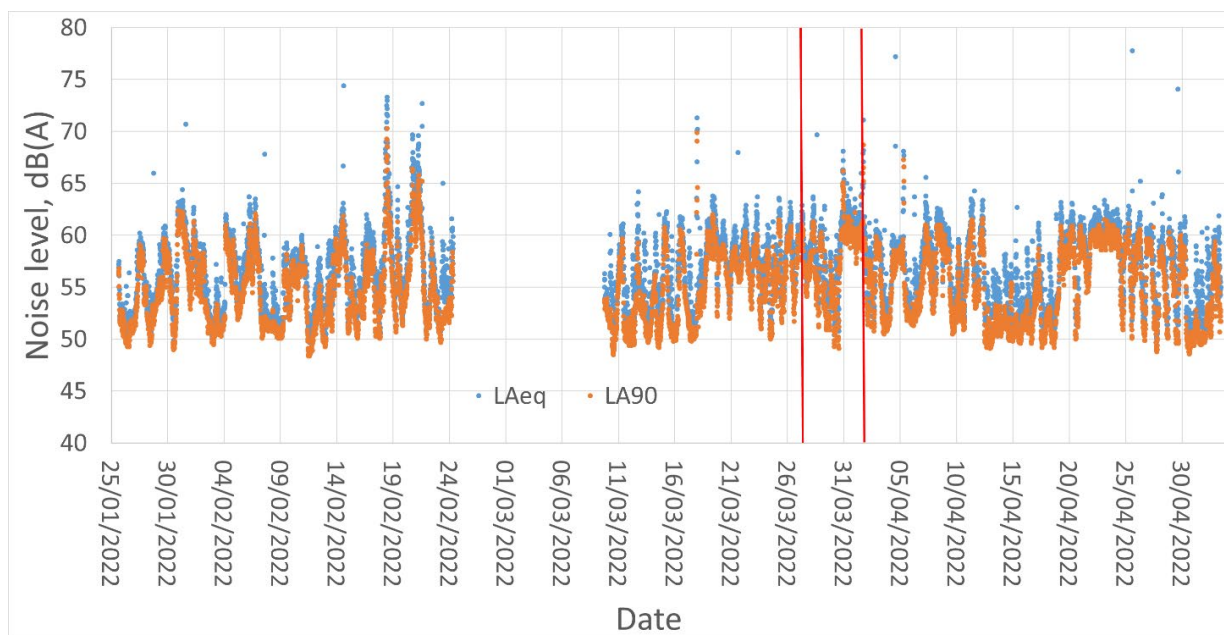
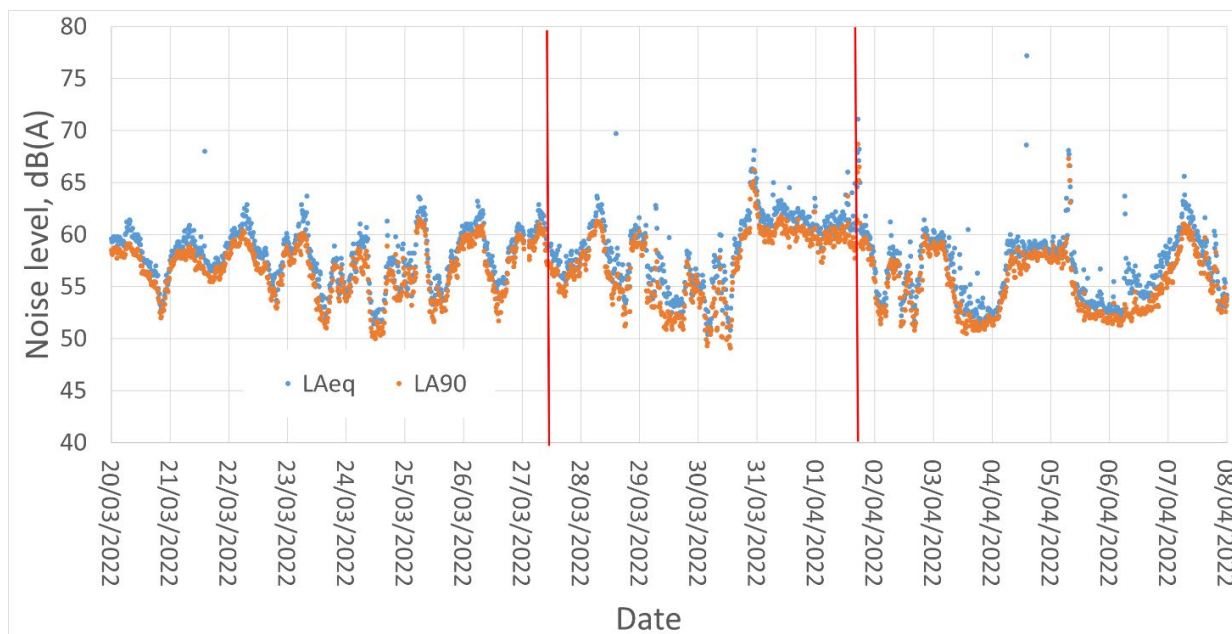


Figure 9: Part of Survey Showing Cogen Shutdown Highlighted in Red



APPENDIX B ASSESSMENT OF THE AUDIBILITY OF TONES RESULTS

This appendix presents the results of the assessment of the audibility of tones carried out whilst the Cogen was operational. Further details are presented in Sections 4.5.2 and 4.5.3.

Table 5: Assessment of the Audibility of Tones

Day, Date and Time	Assessment Results		Tone(s) in the critical band, Hz
	Tonal audibility, ΔL_{ta} , dB re MT	Adjustment value, K_t , dB	
Wednesday 26 January, 02:00	8.4	4.4	63, 99.6
Monday 31 January, 02:00	0.3	0	99.6
Wednesday 2 February, 02:00	0	0	99.6
Thursday 3 February, 02:00	7.8	3.8	99.6
Saturday 5 February, 02:00	5.4	1.4	64.5, 99.6
Monday 7 February, 02:00	3.9	0	99.6
Tuesday 8 February, 02:00	4.5	0.5	99.6
Thursday 10 February, 02:00	4.3	0.3	36.6, 71.8, 99.6
Friday 11 February, 02:00	2.1	0	99.6
Saturday 12 February, 02:00	3.9	0	64.5, 99.6
Monday 14 February, 02:00	---	0	99.6
Tuesday 15 February, 02:00	4	0	99.6
Friday 18 March, 02:45	5.3	1.3	99.6
Sunday 20 March, 02:45	2	0	99.6

Monday 21 March, 02:45	4.7	0.7	99.6
Tuesday 22 March, 02:45	1.9	0	99.6
Wednesday 23 March, 02:45	1.6	0	99.6
Thursday 24 March, 02:45	3.6	0	99.6
Friday 25 March, 02:45	2.5	0	99.6
Saturday 26 March, 02:45	1.7	0	99.6
Sunday 27 March, 00:45	2.3	0	99.6
Sunday 27 March, 02:30	2	0	99.6
Saturday 02 April 2022, 00:30	6.3	2.3	99.6
Saturday 02 April 2022, 02:30	8.2	4.2	99.6
Tuesday 05 April 2022, 02:30	0.5	0	99.6
Thursday 07 April 2022, 02:30	5.7	1.7	221 frequencies between 14.9 kHz and 18.2 kHz
Sunday 10 April 2022, 02:30	6.8	2.8	64.5, 99.6
Tuesday 12 April 2022, 02:30	0	0	99.6
Friday 15 April 2022, 02:30	5.3	1.3	99.6
Saturday 16 April 2022, 02:30	2.6	0	99.6
Sunday 17 April 2022, 02:30	2.3	0	99.6
Tuesday 19 April 2022, 02:30	0	0	99.6

Wednesday 20 April 2022, 02:30	0	0	99.6
Friday 22 April 2022, 02:30	0	0	99.6
Saturday 23 April 2022, 02:15	0	0	99.6
Sunday 24 April 2022, 02:15	0	0	99.6
Monday 25 April 2022, 02:15	0	0	99.6

APPENDIX C CALIBRATION CERTIFICATES



CERTIFICATE OF CALIBRATION




0653

Date of Issue: 03 February 2022

Certificate Number: UCRT22/1166

Calibrated at & Certificate issued by:
ANV Measurement Systems

Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Page 1 of 2 Pages
Approved Signatory 
K. Mistry

Customer ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes
MK5 8HL

Order No. ANV MS HIRE
Description Sound Level Meter / Pre-amp / Microphone / Associated Calibrator
Identification

Manufacturer	Instrument	Type	Serial No. / Version
Rion	Sound Level Meter	NL-52	00932321
Rion	Firmware		2.0
Rion	Pre Amplifier	NH-25	32349
Rion	Microphone	UC-59	18251
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1
Test Procedure TP 2.SLM 61672-3 TPS-49
Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02
If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 19 January 2022 ANV Job No. UKAS22/01042
Date Calibrated 03 February 2022

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Previous Certificate	Dated	Certificate No.	Laboratory
	12 February 2021	UCRT21/1221	0653

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

CERTIFICATE OF CALIBRATION

Certificate Number

UCRT22/1166

UKAS Accredited Calibration Laboratory No. 0653

Page 2 of 2 Pages

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	Sound Level Meter	NL-42 / NL-52
SLM instruction manual ref / issue		11-03
SLM instruction manual source	Manufacturer	
Internet download date if applicable	N/A	
Case corrections available	Yes	
Uncertainties of case corrections	Yes	
Source of case data	Manufacturer	
Wind screen corrections available	Yes	
Uncertainties of wind screen corrections	Yes	
Source of wind screen data	Manufacturer	
Mic pressure to free field corrections	Yes	
Uncertainties of Mic to F.F. corrections	Yes	
Source of Mic to F.F. corrections	Manufacturer	
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes	
Specified or equivalent Calibrator	Specified	
Customer or Lab Calibrator	Lab Calibrator	
Calibrator adaptor type if applicable	NC-74-002	
Calibrator cal. date	17 January 2022	
Calibrator cert. number	UCRT22/1064	
Calibrator cal cert issued by	0653	
Calibrator SPL @ STP	93.98	dB Calibration reference sound pressure level
Calibrator frequency	1002.02	Hz Calibration check frequency
Reference level range	25 - 130	dB

Accessories used or corrected for during calibration - Extension Cable & Wind Shield WS-15

Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End	
Temperature	22.55	22.60	± 0.30 °C
Humidity	39.0	40.4	± 3.00 %RH
Ambient Pressure	100.33	100.32	± 0.03 kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	93.9	dB	Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±				0.10	dB

Self Generated Noise This test is currently not performed by this Lab.

Microphone installed (if requested by customer) = Less Than N/A dB A Weighting

Uncertainty of the microphone installed self generated noise ± N/A dB

Microphone replaced with electrical input device -	UR = Under Range indicated							
Weighting	A		C		Z			
	11.2	dB UR	14.8	dB UR	22.3	dB UR		
Uncertainty of the electrical self generated noise ±					0.12	dB		

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 UKAS requirements.

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

END

Calibrated by: B. Bogdan

R 3

Additional Comments The results on this certificate only relate to the items calibrated as identified above.

None

G. LUFFT Mess- und Regeltechnik GmbH

zertifiziert nach DIN EN ISO 9001 / *certified in accordance with DIN EN ISO 9001*

CERTIFIED
DIN EN ISO 9001
NR 70100222
CERTIFICADO



Kalibrierschein Calibration Certificate

Zertifikatnummer / no. of certificate

7851

LUFFT
calibration

Kalibrierdatum / calibration date

2021-06

Gegenstand
Object **compact weather station WS 600-UMB**

Hersteller
Manufacturer **LUFFT Mess- und Regeltechnik GmbH**

Typ
Type **8370.U02**

Fabrikat/Serien-Nr.
Serial number **309.1114.0701.040**

Auftraggeber
Customer **Equinox Instruments Limited
Beevor Street
LN5 5A LN6 7DJ Lincoln**

Auftragsnummer
Order No. **3027**

Anzahl der Seiten des Kalibrierscheines
Number of pages of the certificate **6**

Datum der Kalibrierung
Date of calibration **16.06.2021 to
17.06.2021**

Dieses Zertifikat dokumentiert die Kalibrierung des genannten Messgerätes unter Berücksichtigung der Zertifizierung nach DIN EN ISO 9001. Die verwendeten Referenzgeräte sind rückgeführt auf nationale Normale. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine ohne Unterschrift und Stempel haben keine Gültigkeit.

This calibration certificate documents the calibration of the mentioned measuring instrument in consideration of the certification in accordance with DIN EN ISO 9001. The used reference standards are traceable to national standards. The user is obliged to have the object recalibrated at appropriate intervals. This calibration certificate may not be reproduced other than in full except with the permission of the issuing laboratory. Calibration certificates without signature and seal are not valid.

G. LUFFT
Stempel
Seal
Mess- u. Regeltechnik GmbH
Gutenbergstraße 20
70736 Fellbach
Postfach 4252
70719 Fellbach

Datum
Date

17.06.2021

Stellv. Leiter des Kalibrierlaboratoriums
Deputy Head of the calibration laboratory

Sven Birbaum

Bearbeiter
Person in charge

Frank Bidmann

Dieser Kalibrierschein ist elektronisch signiert und liegt als Original als PDF-Datei vor.

This calibration certificate is electronic signed and exists as original as PDF-file.

G. LUFFT Mess- und Regeltechnik GmbH
Gutenbergstraße 20
DE-70736 Fellbach
Germany

Tel: ++49(0)711/51822-0
Fax: ++49(0)711/51822-41
E-Mail: info@Lufft.com
www.Lufft.com

Geschäftsführer/Managing directors:
Tom Bolling
Stephan Gramlich
Randall Evers

Amtsgericht Stuttgart
HRB 721373
Ust.ID: DE 250580689
Steuernummer 90490/28336

calibration item

The calibration object is a compact weather station with sensors for temperature, relative humidity, absolute pressure, wind speed, wind direction, precipitation.

Measurement data are available with a RS485 interface.

The calibration object is unscathed.

Temperature

measuring range -50...+60°C
accuracy 0,2°C (-20...50°C), other 0,5°C (>-30°C)
resolution 0,01 K
measuring element NTC

Relative humidity

measuring range 0...100 %
accuracy 2,0 %
resolution 0,01 %
measuring element capacity

Absolute pressure

measuring range 300...1200 mbar
accuracy 0,5 mbar (0°C...40°C)
resolution 0,01 mbar
measuring element capacity

Wind speed

measuring range 0...75 m/s
accuracy 0,3m/s or 3% (0...35m/s), 5% (>35m/s)
resolution 0,01 m/s
measuring element ultrasonic

Wind direction

measuring range 0...359,9°
accuracy 3°
resolution 0,01°
measuring element ultrasonic

reference standard

Temperature

reference standards PT100 resistance thermometer
reference numbers 006418, 006436, 006429, 006430, 006431, 006432
calibration marks 5550-, 5551-, 5552-, 5553-, 5554-, 5555-D-K-15202-01-00-2020-09
uncertainty of measurement 10 mK...15 mK

Temperature

reference standard precision temperature measuring instrument
reference number 801116
calibration mark 2559-D-K-15219-01-00-2021-05
uncertainty of measurement 2 mK

Dew point temperature

reference standard dew point mirror
reference number 601007
calibration mark 7244MBW2019
uncertainty of measurement 30 mK...50 mK

Pressure

reference standard	precision pressure measuring system
reference number	005003
calibration mark	05368950-D-K-15105-01-00-2021-04
uncertainty of measurement	0,013 mbar...0,034 mbar

Velocity measurement unit with different, integrated sensors

Differential pressure

reference standard	differential pressure sensors
reference number	005122
calibration mark	7473-LUFFT-2020-09

Temperature + humidity

reference standard	temperature+humidity-transmitter
reference number	062022
calibration mark	5617-D-K-15202-01-00-2020-09

Absolute pressure

reference standard	absolute pressure sensor
reference number	005022
calibration mark	5618-D-K-15202-01-00-2020-09

precipitation

doppler-simulator

reference standard	K-Band doppler-simulator
reference number	801070

frequency

reference standard	oscilloscope
reference number	801069
calibration mark	E-1908381

calibration procedure

Temperature:

The temperature calibration was accomplished after the calibration instruction "Calibration of temperature measuring instruments" N9003.

A direct comparison between the used reference standard and the calibration item was accomplished.

The temperature values (t_{90}) refer to the International Temperature Scale of 1990 (ITS-90).

Humidity:

The humidity calibration was accomplished after the calibration instruction "Calibration of humidity measuring instruments" N9004. A direct comparison between the used reference standard and the calibration item was accomplished.

The temperature values refer to the International Temperature Scale of 1990 (ITS-90).

Pressure:

The pressure calibration was accomplished after the calibration instruction "Calibration of pressure measuring instruments" N9103. A direct comparison between the used reference standard and the calibration item was accomplished.

Air velocity:

The airflow calibration was accomplished after the calibration instruction "Calibration of airflow measuring instruments" N9007. A direct comparison between the used reference standard and the calibration item was accomplished.

measurement conditions

temperature / relative humidity:

climate chamber, medium: air

The relative humidity has been calculated from measured air and dew point temperature.

description:

Adaptation time was at least 120 minutes for every calibration point.

The calibration unit was placed in the center of the climate chamber and was completely exposed to the climate conditions.

The measurement values of the calibration object ("indicated value") were recorded with a LUFFT-ISOCON and the recorder-function of the Software UMB-config-tool V2.7. The recording interval was 10 seconds. The power supply was 24 VDC.

absolute pressure

pressure transmission medium: dry air
 reference layer calibration object: top edge of the case
 Position during calibration: vertical

air velocity:

wind tunnel, medium: air
 diameter nozzle outlet: 255 mm

precipitation:

The calibration procedure for the radar precipitation sensor uses electronic simulation. A doppler simulator modifies the radar signal by modulating an additional frequency on it which corresponds to a given fall velocity of the drop. The drop diameter can then be determined from the correlation between the fall velocity and the size of the drop.

ambient conditions

temperature in °C: 22,8 1 K
 rel. humidity in %: 42 10 %
 air pressure in mbar: 981 10 mbar

calibration results

Temperature calibration

Reference standard	Calibration unit		
temperature t_{90} in °C	indicated value t_{90} in °C	measurement deviation T_{90} in K	uncertainty of measurement U in K
-0,03	-0,12	-0,09	0,15
19,76	19,70	-0,06	0,14
39,96	39,85	-0,11	0,14

Humidity calibration

Reference standards		Calibration unit		
air-temperature t_{90} in °C	relative humidity U_w in %	indicated value U in %	measurement deviation U in %	uncertainty of measurement U in %
20	19,5	20,7	+1,2	0,6
20	50,2	52,2	+2,0	0,9
20	80,2	81,6	+1,4	1,4

Pressure calibration

reference standard	calibration item	
	p_{Anzeige}	
p_{Normal} in mbar	M1 (up) in mbar	M2 (down) in mbar
751,0	751,2	751,3
850,0	850,2	850,2
925,0	925,2	925,2
1000,0	1000,1	1000,1
1099,0	1098,9	1098,9

Interpretation:

reference standard	calibration item			
	absolute pressure p_{Normal} in mbar	mean value p_{Miw} in mbar	measurement deviation p in mbar	hysteresis h in mbar
751,0	751,3	+0,3	0,1	0,3
850,0	850,2	+0,2	0,0	0,3
925,0	925,2	+0,2	0,0	0,3
1000,0	1000,1	+0,1	0,0	0,3
1099,0	1098,9	-0,1	0,0	0,3

air velocity calibration

Nr.	reference	calibration object	
	flow u in m/s	indicated value with RMSE calculation at 32 directions u in m/s	measurement deviation u in m/s
1	2,00	1,95	-0,05
2	5,00	5,04	+0,04
3	10,00	10,06	+0,06
4	20,00	19,93	-0,07
5	50,02	50,37	+0,35

direction calibration

Nr.	reference	calibration object
	flow u in m/s	measurement deviation with RMS calculation of 32 directions in °
1	2,0	2,2
2	5,0	0,9
3	10,0	0,7
4	20,0	0,7
5	50,0	1,3

precipitation drop size calibration

reference	calibration object	
drop size in mm	indicated value in mm	measurement deviation in mm
0,115	0,115	0,000
0,670	0,670	0,000
2,730	2,728	-0,002

observations

The uncertainty stated is the expanded uncertainty U obtained by multiplying the standard uncertainty by the coverage factor $k = 2$. It has been determined in accordance with EA-4/02 M. The value of the measurand lies with a normal distribution with a probability of approximately 95 % within the assigned range of values.



CERTIFICATE OF CALIBRATION



0653

Date of Issue: 20 July 2021

Certificate Number: UCRT21/1889

Calibrated at & Certificate issued by:

ANV Measurement Systems

Beaufort Court

17 Roebuck Way

Milton Keynes MK5 8HL

Telephone 01908 642846 Fax 01908 642814

E-Mail: info@noise-and-vibration.co.uk

Web: www.noise-and-vibration.co.uk

Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Page 1 of 2 Pages
Approved Signatory
K. Mistry

Customer ANV Measurement Systems
 Beaufort Court
 17 Roebuck Way
 Milton Keynes
 MK5 8HL

Order No. ANV MS HIRE
 Description Sound Level Meter / Pre-amp / Microphone / Associated Calibrator
 Identification

Manufacturer	Instrument	Type	Serial No. / Version
Rion	Sound Level Meter	NL-52	00620869
Rion	Firmware		2.0
Rion	Pre Amplifier	NH-25	20929
Rion	Microphone	UC-59	11318
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1
 Test Procedure TP 2.SLM 61672-3 TPS-49
Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02
If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 15 July 2021 ANV Job No. UKAS21/07466
 Date Calibrated 20 July 2021

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Previous Certificate	Dated	Certificate No.	Laboratory
	12 February 2021	UCRT21/1218	0653

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

CERTIFICATE OF CALIBRATION

Certificate Number

UCRT21/1889

UKAS Accredited Calibration Laboratory No. 0653

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Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	Sound Level Meter	NL-42 / NL-52
SLM instruction manual ref / issue		11-03
SLM instruction manual source		Manufacturer
Internet download date if applicable		N/A
Case corrections available		Yes
Uncertainties of case corrections		Yes
Source of case data		Manufacturer
Wind screen corrections available		Yes
Uncertainties of wind screen corrections		Yes
Source of wind screen data		Manufacturer
Mic pressure to free field corrections		Yes
Uncertainties of Mic to F.F. corrections		Yes
Source of Mic to F.F. corrections		Manufacturer
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes	
Specified or equivalent Calibrator		Specified
Customer or Lab Calibrator		Lab Calibrator
Calibrator adaptor type if applicable		NC-74-002
Calibrator cal. date		28 June 2021
Calibrator cert. number		UCRT21/1792
Calibrator cal cert issued by		0653
Calibrator SPL @ STP	94.02	dB Calibration reference sound pressure level
Calibrator frequency	1002.00	Hz Calibration check frequency
Reference level range	25 - 130	dB

Accessories used or corrected for during calibration - Extension Cable & Wind Shield WS-15
 Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End	
Temperature	25.55	25.54	± 0.30 °C
Humidity	45.4	45.7	± 3.00 %RH
Ambient Pressure	100.92	100.90	± 0.03 kPa

Response to associated Calibrator at the environmental conditions above.			
Initial indicated level	94.0	dB	Adjusted indicated level
			94.0 dB
The uncertainty of the associated calibrator supplied with the sound level meter ±			0.10 dB

Self Generated Noise	This test is currently not performed by this Lab.		
Microphone installed (if requested by customer) = Less Than	N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±	N/A	dB	

Microphone replaced with electrical input device -	UR = Under Range indicated							
Weighting	A		C		Z			
	13.6	dB UR	17.2	dB UR	23.8	dB UR		
Uncertainty of the electrical self generated noise ±					0.12	dB		

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 UKAS requirements.

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

END

Calibrated by: **B. Bogdan**

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Additional Comments The results on this certificate only relate to the items calibrated as identified above.

None