Appendix A9.1
Noise & Vibration Survey

Contents

Appendix A9.1: Baseline Noise and Vibration Survey

1. Baseline Noise Monitoring

1.1 Introduction

This report includes the relevant survey details and results associated with baseline noise monitoring undertaken as part of the Ringsend to City Centre Core Bus Corridor (hereafter referred to as the Proposed Scheme). The survey has been undertaken to inform the noise and vibration chapter of the Proposed Scheme EIAR.

Survey details and results for each of the noise monitoring locations are included within this report.

1.2 Survey Methodology

1.2.1 Study Area

The assessment study area is split into three geographical zones, as described in Table 1.

Table 1: Description of Noise Sensitive Locations (NSLs) Across the Study Area

Geographical Zone	Description of Study Area
Talbot Memorial Bridge to Tom Clarke East Link Bridge	Between Talbot Memorial Bridge on Custom House Quay to Tom Clarke East Link Bridge on North Wall Quay, the key NSLs are residential apartments immediately adjacent to these routes. However, the area is predominantly medium NSLs such as commercial office properties including IFSC House, the Convention Centre, Central Bank of Ireland, and hotel properties including Jury's Inn Hotel, Hilton Garden Inn, The Spencer, and The Mayson, all located within 5m to 10m of the road edge. Between Talbot Memorial Bridge on City Quay to on the eastern extent of Sir John Rogerson's Quay, NSLs are predominantly of medium sensitivity as the area has a range of commercial office buildings located within 5m to 10m of the City Quay and Sir John Rogerson's Quay existing road edge. High sensitivity NSL residential dwellings are located at Peterson's Court and Lombard Court, which bound the south of City Quay at distances of 10m to 15m from the road edge, Hanover Riverside Apartments, Longboat Quay North Apartments and Butlers Court, which bound the south of Sir John Rogerson's Quay at a distance of 5m from the road edge.
Dodder Public Transport Opening Bridge (DPTOB)	Spanning from west to east over the confluence of the River Dodder and the River Liffey from Sir John Rogerson's Quay to Thorncastle Street / York Road. To the west of the River Dodder, NSLs are predominantly high sensitivity NSL residential dwellings which bound the south of Sir John Rogerson's Quay existing road edge, including Hanover Riverside Apartments, Longboat Quay North Apartments and Butlers Court, which bound the south of Sir John Rogerson's Quay at a distance of 5m from the road edge. To the east of the confluence of the River Dodder and the River Liffey, NSLs are predominantly high sensitivity NSL residential dwellings which bound the south of Thorncastle Court, including Portview Apartments, Thorncastle Court, which are located at distances of 5m to 15m from the road edge.
Tom Clark East Link Bridge to Sean Moore Road	Between the Tom Clarke East Link Bridge and Sean Moore Road the key NSLs are predominantly high sensitivity NSL residential dwellings which bound the south of York Road and Pigeon House Road, including Portview Apartments, Thorncastle Court, Pembroke Cottages and Poolbeg Quay apartments, which are located at distances of 5m to 15m from the edge of these local roads. Educational receptors include Ringsend College along York Road at a distance of 5m from the road edge. Ringsend & Irishtown Community Centre is located within 100m of the Proposed Scheme. Other sensitive residential NSLs include those along the cycle route from Cambridge Park, Kerlogue Road and Bremen Road, located within 5m to 10m of these local roads. Recreational amenity NSLs in the area include St Patrick's Rowing Club (SPRC) and Irishtown Stadium.

1.2.2 Survey Locations

Baseline noise surveys have been conducted at locations representative of the nearest noise sensitive areas which have the potential to be impacted by construction works and / or those likely to be impacted during the Operational Phase of the Proposed Scheme. Both attended and unattended noise surveys were undertaken to inform the assessment:

- Unattended surveys (typically one week in duration) were made at one location; and
- Attended surveys (day-time measurements), were made at a total of nine locations along the length of the Proposed Scheme.

Figure 9.2, in Volume 3 of this EIAR illustrates the baseline noise monitoring locations. Each is discussed in the relevant geographical zone in the following sections.

1.2.2.1 Talbot Memorial Bridge to Tom Clarke East Link Bridge

A total of one unattended monitoring locations and four attended survey locations were surveyed within this study area. The location reference and a description of survey positions are included in Table 2.

Table 2: Noise Monitoring Locations – Talbot Memorial Bridge to Tom Clarke East Link Bridge

Location	Description of Survey Location
Unattended Monitoring Location	
CBC0016UNML001	In external roof garden on first floor of residential NSL in Capital Dock, Britain Quay facing east towards River Dodder
Attended Monitoring Locations	
CBC0016ANML001	On footpath to east of R801 North Wall Quay / Castleforbes Road junction, in line with façade of NSLs lining R801 North Wall Quay. Located approximately 5m from R801 road edge.
CBC0016ANML002	On footpath to southeast of R801 North Wall Quay / North Wall Avenue junction. Located approximately 10m from R801 road edge.
CBC0016ANML003	On footpath to east of R813 City Quay / Lombard Street East junction, in line with façades of residential NSLs facing onto R813 City Quay. Located approximately 10m from R813 road edge.
CBC0016ANML004	On footpath to east of Misery Hill / Hibernian Road junction, in line with façade of The Marker Hotel Dublin. Located approximately 10m from Misery Hill road edge.

1.2.2.2 Dodder Public Transport Opening Bridge (DPTOB)

A total of one unattended measurement location was surveyed within this study area. The location reference and a description of survey position is included in Table 3.

Table 3: Noise Monitoring Locations – Dodder Public Transport Opening Bridge

Location	Description of Survey Location
Unattended Monitoring Location	
CBC0016UNML001	In external roof garden on first floor of residential NSL in Capital Dock, Britain Quay facing east towards River Dodder.

1.2.2.3 Tom Clark East Link Bridge to Sean Moore Road

A total of five attended survey locations were surveyed within this study area. The location reference and a description of survey positions are included in Table 4.

Table 4: Noise Monitoring Locations – Tom Clark East Link Bridge to Sean Moore Road

Location	Description of Survey Location
Attended Monitoring Locations	
CBC0016ANML005	On footpath to south of Thorncastle Street, on road edge approximately 1m from residential NSLs.
CBC0016ANML006	On footpath to south of York Road, on road edge approximately 1m from residential NSLs.
CBC0016ANML007	On footpath to east of Ringsend College, in line with residential NSLs along Pigeon House Road. Located approximately 3m from road edge.
CBC0016ANML008	On footpath to west of entrance to a large green on Pigeon House Road, in line with residential NSLs to west and terraced houses to the south. Located approximately 25m to R131 to the north, shipyard 200 m to the northeast.
CBC0016ANML009	On grass on small green between two rows of terraced houses at St Brendan's Cottages, park to the north east, main road to the south west.

1.2.3 Survey Periods

The unattended noise survey was undertaken between 10 March 2020 and 20 March 2020. The specific survey dates and times for the location is included in the survey results tables in Section 1.3.

Attended noise surveys were undertaken during February to March 2020 and June, August and September 2020. The specific survey dates and times for each location are included in the survey results tables in Section 1.3.

1.2.4 Survey Equipment and Personnel

The unattended survey was undertaken using RION NL-52 sound level meter. The attended surveys were undertaken using either RION NL-52 or Brυel and Kjær 2250L sound level meters. The specific equipment details are summarised in Table 5.

The attended surveys were undertaken using either RION NL-52 and Brυel and Kjær 2250L sound level meters. The specific equipment details are summarised in Table 5.

Table 5: Noise Monitoring Equipment

Survey Type	Equipment	Serial Number	Calibration Date
Unattended	Rion NL-52	1076328	15/08/2018
Attended	Rion NL-52	998413	22/01/2020
	Brυel and Kjær 2250	3028635	03/10/2019
	Brυel and Kjær 2250L	3008402	04/11/2019

Calibration certificate of the monitoring equipment are included within Section 3.

For unattended surveys, a Rion WS-15 Outdoor Microphone Protection System with microphone extension cable and outdoor peli-case was used. An image of the equipment install at the one unattended monitoring location is included in Section 4.

The surveys were conducted by Jack Brennan, Alex Ryan and David O'Donoghue, acoustic technicians, AWN Consulting.

1.2.5 Survey Parameters

The following noise parameters were measured and are discussed within this report.

$L_{Aeq,T}$ is the A-weighted equivalent continuous steady sound level during the sample period and effectively represents an average value of the defined measurement period, T.

$L_{Aeq,16hr}$ refers to the ambient daytime period between 07:00 and 23:00hrs.

$L_{A10,T}$ is the A-weighted sound level that is exceeded for 10% of the sample period; this parameter gives an indication of the upper limit of fluctuating noise such as that from road traffic. The T is the sample period the parameter is measured over.

$L_{A10,18hr}$ is the L_{A10} parameter between 06:00 and 00:00hrs as defined within the Calculation of Road Traffic Noise (hereafter referred to as CRTN) (UK Department of Transport 1998).

$L_{A90,T}$ is the A-weighted sound level that is exceeded for 90% of the sample period; generally used to quantify background noise. The T is the sample period the parameter is measured over.

$L_{A90,16hr,}$ refers to the background daytime noise level between 07:00 and 23:00hrs

$L_{A90,8hr}$, refers to the background night-time noise level between 23:00 and 07:00hrs

The L_{den} parameter is also discussed within the report. For long-term survey locations, this parameter is derived from the L_{Aeq} data over each 24 hour period as is defined as follows:

L_{den} is the 24hour noise rating level determined by the averaging of the L_{day} with the $L_{evening}$ (plus a 5dB penalty) and the L_{night} (plus a 10dB penalty). L_{den} is calculated using the following formula, as defined within the Environmental Noise Regulations (S.I.140 / 2006):

$$L_{den} = 10log\left(\frac{1}{24}\right)\left(12 * \left(10^{\frac{Lday}{10}}\right) + 4 * \left(10^{\frac{Levening+5}{10}}\right) + 8 * \left(10^{\frac{Lnight+10}{10}}\right)\right)$$

Where:

L_{day} is the A-weighted long-term average sound level as defined in ISO 1996-2:2017 Part 2: Determination of sound pressure levels (hereafter referred to as ISO 1996-2) (ISO 2017), determined over all the day periods of a year. The 12hr daytime period is between 07:00 to 19:00hrs.

$L_{evening}$ is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the evening periods of a year. The 4hr evening period is between 19:00 to 23:00hrs.

L_{night} is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the night periods of a year. The 8hr night-time period is between 23:00 to 07:00hrs.

1.2.6 Survey Procedure

Noise measurements were conducted in general accordance with the guidance contained in ISO 1996-1:2016 Acoustics – Description measurement and assessment and environmental noise. Part 1: Basic quantities and assessment procedures (hereafter referred to as ISO 1996-1) (ISO 2016) and ISO 1996-2 (ISO 2017).

1.2.6.1 Unattended Measurements

For the unattended noise survey, the monitoring equipment was installed in an external roof garden of the first floor of an apartment development. The microphone was installed at a height of approximately 1.5m above ground. The equipment was set to log for 15 minute intervals on a continual basis over a ten day period.

1.2.6.2 Attended Measurements

Attended noise surveys were undertaken at public locations at positions representative of the adjacent noise sensitive locations (e.g. on green areas in residential areas, footpaths, parks etc.). For all attended surveys, the microphone was positioned at height of approximately 1.2m above ground.

The attended surveys were undertaken in accordance with the shortened measurement procedure described in CRTN (UK Department of Transport 1998) and Transport Infrastructure Ireland's (TII) document Guidelines for the Treatment of Noise and Vibration on National Road (TII 2004).

This methodology involves a method whereby $L_{A10(18hour)}$ and L_{den} values are obtained through a combination of measurement and calculation as follows:

- Noise level measurements are undertaken at the chosen location over three consecutive hours between 10:00 and 17:00hrs.
- Each sample period was measured over a 15 minute duration.
- The $L_{A10(18hour)\ for}$ the location is derived by subtracting 1 dB from the arithmetic average of the three hourly sample values, i.e.

  $L_{A10(18hour)} = ((\sum L_{A10(15\ minutes)}) \div 3) - 1$ dB.
- The derived L_{den} value is calculated from the $L_{A10(18hour)}$ value, i.e.

  $L_{den} = 0.86 \times L_{A10(18hr)} + 9.86$ dB.

1.3 Survey Results

1.3.1 Talbot Memorial Bridge to Tom Clarke East Link Bridge

1.3.1.1 Attended Surveys

The attended noise survey results recorded during the baseline surveys within this study area are presented in Table 6.

Table 6: Attended Noise Survey Results for Talbot Memorial Bridge to Tom Clarke East Link Bridge

Attended Location	Date	Start Time	Measured Noise Levels (dB re.2x10^{-5}Pa)			Derived L_{den}	Survey Notes
			L_{Aeq}	L_{A10}	L_{A90}		
CBC0016ANML001	12/08/2020	10:56	69	73	54	71	Road traffic from R801 North Wall Quay, birdsong.
		12:04	69	72	56		
		13:21	70	73	54		
CBC0016ANML002	04/02/2020	13:24	68	71	60	70	Road traffic from R801 North Wall Quay, construction noise from North Dock site, birdsong, pedestrian conversations, passing HGVs throughout.
		14:29	69	71	59		
		15:31	69	71	61		
CBC0016ANML003	12/08/2020	11:40	64	67	52	67	Road traffic from Lombard Street and R813 City Quay, pedestrian crossing beacon.
		12:47	65	67	52		
		14:03	64	66	52		
CBC0016ANML004	12/08/2020	11:18	61	64	55	65	Road traffic from Hibernian Road.
		12:26	62	65	55		
		13:42	64	65	55		Road traffic from Hibernian Road, pedestrian conversation at 11 mins.

1.3.2 Dodder Public Transport Opening Bridge (DPTOB)

1.3.2.1 Unattended Surveys

The unattended noise survey results recorded during the baseline surveys within this study area are presented in Table 7.

Table 7: Unattended Noise Survey Results for Talbot Memorial Bridge to Tom Clarke East Link Bridge

Survey Date	Daytime				Evening	Night-Time			L_{den}
	$L_{Aeq,16hr}$	L_{day}	$L_{A10,16hr}$	$L_{A90,16hr}$	$L_{evening}$	L_{night}	$L_{A10,8hr}$	$L_{A90,8hr}$	
CBC0016UNML001									
10/03/2020	56	58	56	52	52	51	52	47	59
11/03/2020	55	56	56	53	53	52	53	49	59
12/03/2020	56	57	56	52	53	52	53	48	59
13/03/2020	58	59	59	54	57	51	52	48	60
14/03/2020	53	54	55	51	52	50	52	48	58
15/03/2020	53	54	53	49	51	50	50	46	57
16/03/2020	53	55	54	49	51	48	49	45	56
17/03/2020 Note 1	52	53	53	48	50	50	51	46	57
18/03/2020	55	57	55	50	50	50	51	46	58
19/03/2020	56	58	57	53	53	52	53	48	60
Average	55	57	56	51	53	51	52	47	59

Note 1: Noise data recorded during the Public Holiday on 17 March 2020 has been excluded from the overall average.

Road traffic from R801 North Wall Quay and R813 Sir John Rogerson's Quay are the dominant noise source at the monitoring position in the vicinity of the Proposed Scheme. During daytime periods, average ambient noise levels were recorded in order of 55 dB $L_{Aeq,16hr}$. Average background daytime noise levels were measured in the order of 51 dB $L_{A90,16hr}$.

Night-time noise levels at the monitoring location are dominated by road traffic from R801 North Wall Quay and R813 Sir John Rogerson's Quay. Average ambient night-time noise levels were measured in the order of 51 dB $L_{Aeq,8hr}$. Average background noise levels during this time period were measured in the order of 47 dB $L_{A90,8hr}$.

The measured L_{den} values in this geographic section is in the order of 59 dB L_{den}.

1.3.3 Tom Clark East Link Bridge to Sean Moore Road

1.3.3.1 Attended Surveys

The attended noise survey results recorded during the baseline surveys within this study area are presented in Table 8.

Table 8: Attended Noise Survey Results for Tom Clark East Link Bridge to Sean Moore Road

Attended Location	Date	Start Time	Measured Noise Levels (dB re.2x10^{-5}Pa)			Derived L_{den}	Survey Notes
			L_{Aeq}	L_{A10}	L_{A90}		
CBC0016ANML005	04/02/2020	14:07	59	60	56	61	Road traffic from R131 East Link Toll Bridge, birdsong, distant North Dock construction noise, pedestrian conversations, sirens at 1 min.
		15:08	60	59	55		Road traffic from R131 East Link Toll Bridge, birdsong, distant North Dock construction noise, pedestrian conversations, loud truck horn at 11 mins, sirens at 14 min.
		16:12	58	60	56		Road traffic from R131 East Link Toll Bridge, birdsong, distant North Dock construction noise, pedestrian conversations, car pulling out of spot at 1 min.
CBC0016ANML006	04/02/2020	13:48	64	66	59	65	Road traffic from R131 East Link Toll Bridge, pedestrian conversation, birdsong, large trucks coming through toll, loud truck horn at 7 mins.
	08/09/2020	14:50	63	65	59		Road traffic from R131 East Link Toll Bridge, pedestrian conversation, birdsong, large trucks coming through toll, distant North Dock construction noise.
		15:54	63	64	59		
CBC0016ANML007	18/06/2020	13:12	64	66	58	65	Road traffic from R131 East Link Toll Bridge and Pigeon House Road, loud voice at 12 mins.
	08/09/2020	14:36	62	64	56		Road traffic from R131 East Link Toll Bridge and Pigeon House Road.
		15:58	62	64	55		
CBC0016ANML008	18/06/2020	11:52	62	65	55	63	Heavy Goods Vehicles Road traffic from R131 East Link Toll Bridge, pedestrian conversations.
	08/09/2020	14:14	60	63	54		Road traffic from R131 East Link Toll Bridge and Pigeon House Road, loud trucks passing, noise from trailers.
		15:37	59	61	54		Road traffic from R131 East Link Toll Bridge and Pigeon House Road, loud trucks passing, noise from trailers, dog barking at 1 min.
CBC0016ANML009	18/06/2020	10:22	52	54	46	54	Road traffic from R802 Irishtown Road, pedestrian conversation, yelling at 2 mins.
	08/09/2020	13:44	48	50	45		Road traffic R802 Irishtown Road, pedestrian conversation, wind trees and bushes, faint road traffic from R131 Sean Moore Road.
		15:03	50	53	45		

2. Baseline Vibration Monitoring

2.1 Introduction

This section includes the relevant survey details and results associated baseline vibration surveys conducted as part of the overall Bus Connects Dublin – Core Bus Corridor Infrastructure Works (hereafter referred to as the Proposed Works). Baseline vibration data obtained from this study has been used to information all individual Bus Connects Core Bus Corridor Schemes.

2.2 Survey Methodology

2.2.1 Survey Locations

Attended vibration monitoring was undertaken at sample locations adjacent to existing bus lanes within Dublin City. The surveys were undertaken to obtain typical baseline vibration levels along roads with both mixed vehicular traffic lanes and individual bus lanes. This information has been used to inform the operational vibration impact assessment for the Proposed Scheme.

Surveys were also undertaken along an access road to the Harristown Bus Depot, Horizon Logistics Park, Swords, Co. Dublin, to obtain a measurement of vibration relating to specific bus drive by in isolation at a controlled sampling location to characterise the specific vibration level associated with buses in the absence of other traffic. A description of the survey locations is set out in Table 9.

Table 9: Vibration Monitoring Locations

Vibration Monitoring Locations	Description of Survey Location
AVML001	Harristown – Entrance Road to Bus Depot, midway along inbound road, 5m from road edge
AVML002	Harristown – Roundabout at Bus Depot entrance, buses entering depot, 5m from road edge
AVML003	Harristown – Roundabout at Bus Depot entrance, buses exiting depot, 5m from road edge
AVML004	Harristown – Entrance Road to Bus Depot, midway along outbound road, 5m from road edge
AVML005	Harristown – Entrance Road to Bus Depot, midway along inbound road, 7m from road edge
AVML006	Malahide Road / St. Johns Court – 5m from edge of Inbound Bus Lane
AVML007	Malahide Road / St. Johns Court – 10m from edge of Inbound Bus Lane
AVML008	Malahide Road / Donnycarney Church – 2.5m from edge of Inbound Bus Lane
AVML009	Malahide Road– 2.5m from edge of outbound Bus Lane

The survey locations undertaken along the Harristown Bus Depot entrance are illustrated in Figure 1. The survey locations undertaken along the Malahide Road are illustrated in Figure 2.

Figure 1: Vibration Monitoring Locations Harristown Bus Depot (source Google Earth)

Figure 2: Vibration Monitoring Locations Malahide Road (source Google Earth)

2.2.2 Survey Periods

Vibration monitoring was undertaken on the following dates:

- AVML001 - AVML005: 30th July 2020; and
- AVML005 – AMML009: 13th August 2020

2.2.3 Survey Equipment and Personnel

The survey was undertaken using a RION VM-56 vibration meter (S/N 680043) with PV-83D tri-axial accelerometer. Calibration certificate of monitoring equipment are included within Section 3.

The surveys were conducted Alex Ryan and David O'Donoghue, acoustic technicians, AWN Consulting.

2.2.4 Survey Procedure

Vibration measurements were conducted in general accordance with the guidance contained in British Standard BS 7385. Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings (1990).

Vibration was measured in the three orthogonal axes. The accelerometer was secured in place with a 5kg sandbag at all monitoring locations.

The equipment was set to log for 1 minute intervals on a continual basis with an instantaneous storage interval of 100ms. Vibration monitoring periods at AVML001 to AVML005 along the entrance road to Harristown Bus Depot were undertaken for a period of 15 minutes at each position. Vibration monitoring periods at AVML006 to AVML009 along the Malahide Road were undertaken for a period of 30 minutes at each position.

2.2.5 Survey Parameters

The following vibration parameters are discussed within this report.

PPV Peak Particle Velocity (PPV) is a measure of the velocity of vibration displacement in terms of millimetres per second (mm/s). It is defined as follows within BS 7385: (1990) as:

> *"the maximum instantaneous velocity of a particle at a point during a given time interval"*

VDV Vibration Dose Value (VDV) is an evaluation of human exposure to vibration in buildings. It defines a relationship that yields a consistent assessment of continuous, intermittent, occasional, and impulsive vibration and correlates well with subjective response. It is defined as follows within British Standard BS 6472: (2008) Guide to evaluation of human exposure to vibration in buildings (2008): Part 1 - Vibration sources other than blasting, as:

> *"The VDV is the fourth root of the integral of the fourth power of acceleration after it has been frequency-weighted (as defined in BS6472: 2008). The frequency-weighted acceleration is measured in m/s2 and the time period over which the VDV is measured is in seconds. This yields VDVs in m/s1.75"*

The frequency weightings used in the BS 6472 (2008) document is Wb weighting for vertical axis and Wd for the horizontal axes.

2.3 Survey Results – Harristown Bus Depot

The vibration survey results measured at each location are presented for each pass by event (bus drive by) in terms of the PPV parameter in mm/s and in terms of the VDV parameter in $m/s^{1.75}$ for each axis.

2.3.1 Location AVML001

Table 10 presents the results of vibration values associated with individual bus drive events by during the monitoring period at this location.

Table 10: Vibration Monitoring Results at ANML001

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$		
	X	Y	Z	X	Y	Z
14:57	0.05	0.05	0.06	0.0003	0.0003	0.0020
15:01	0.03	0.04	0.04	0.0002	0.0003	0.0016
15:02	0.03	0.03	0.03	0.0002	0.0002	0.0008
15:03	0.02	0.04	0.04	0.0001	0.0002	0.0016
15:04	0.03	0.02	0.06	0.0002	0.0002	0.0022
15:05	0.04	0.05	0.08	0.0002	0.0002	0.0028
15:06	0.03	0.04	0.03	0.0002	0.0002	0.0013
15:07	0.03	0.04	0.05	0.0002	0.0002	0.0018
Minimum event	0.02	0.02	0.03	0.0001	0.0002	0.0008
Maximum event	0.05	0.05	0.08	0.0003	0.0003	0.0028

2.3.2 Location AVML002

Table 11 presents the results of vibration values associated with individual bus drive events by during the monitoring period at this location.

Table 11: Vibration Monitoring Results at ANML002

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$		
	X	Y	Z	X	Y	Z
15:22	0.03	0.03	0.08	0.0002	0.0002	0.0019
15:26	0.02	0.03	0.03	0.0002	0.0002	0.0012
15:29	0.02	0.07	0.09	0.0002	0.0003	0.0014
15:30	0.02	0.02	0.07	0.0001	0.0002	0.0019
15:31	0.03	0.04	0.06	0.0002	0.0002	0.0024
15:32	0.02	0.03	0.07	0.0002	0.0002	0.0022
15:33	0.03	0.03	0.06	0.0002	0.0002	0.0014
15:34	0.02	0.02	0.04	0.0001	0.0002	0.0016
Minimum event	0.03	0.07	0.09	0.0002	0.0003	0.0024
Maximum event	0.02	0.02	0.03	0.0001	0.0002	0.0012

2.3.3 Location AVML003

Table 12 presents the results of vibration values associated with individual bus drive events by during the monitoring period at this location.

Table 12: Vibration Monitoring Results at ANML003

Event Time	PPV, mm/s			$VDV_{,b,d}$, $m/s^{1.75}$		
	X	Y	Z	X	Y	Z
15:40	0.06	0.06	0.09	0.0003	0.0003	0.0031
15:43	0.07	0.05	0.07	0.0003	0.0003	0.0027
15:44	0.04	0.05	0.06	0.0002	0.0003	0.0021
15:45	0.07	0.05	0.07	0.0003	0.0003	0.0032
15:49	0.03	0.03	0.03	0.0002	0.0002	0.0014
15:50	0.06	0.06	0.05	0.0003	0.0004	0.0027
Minimum event	0.07	0.06	0.09	0.0003	0.0004	0.0032
Maximum event	0.03	0.03	0.03	0.0002	0.0002	0.0014

2.3.4 Location AVML004

Table 13 presents the results of vibration values associated with individual bus drive events by during the monitoring period at this location.

Table 13: Vibration Monitoring Results at ANML004

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$		
	X	Y	Z	X	Y	Z
16:04	0.08	0.12	0.1	0.0006	0.0008	0.0060
16:06	0.09	0.1	0.13	0.0004	0.0006	0.0061
16:08	0.1	0.13	0.11	0.0005	0.0008	0.0049
16:09	0.07	0.1	0.12	0.0005	0.0006	0.0049
16:10	0.11	0.12	0.15	0.0006	0.0007	0.0072
16:11	0.08	0.09	0.1	0.0005	0.0006	0.0046
16:12	0.07	0.08	0.11	0.0004	0.0006	0.0059
16:13	0.07	0.09	0.11	0.0004	0.0005	0.0054
Minimum event	0.11	0.13	0.15	0.0006	0.0008	0.0072
Maximum event	0.07	0.08	0.1	0.0004	0.0005	0.0046

2.3.5 Location AVML005

Table 14 presents the results of vibration values associated with individual bus drive events by during the monitoring period at this location.

Table 14: Vibration Monitoring Results at ANML005

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$		
	X	Y	Z	X	Y	Z
16:36	0.03	0.02	0.03	0.0002	0.0002	0.0013
16:39	0.02	0.03	0.03	0.0002	0.0002	0.0017
16:40	0.03	0.04	0.04	0.0002	0.0003	0.0015

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$		
	X	Y	Z	X	Y	Z
16:44	0.03	0.04	0.06	0.0002	0.0003	0.0021
16:46	0.03	0.03	0.03	0.0002	0.0002	0.0012
16:47	0.03	0.03	0.03	0.0002	0.0002	0.0013
16:48	0.03	0.03	0.04	0.0002	0.0002	0.0012
Minimum event	0.02	0.02	0.03	0.0002	0.0002	0.0012
Maximum event	0.03	0.04	0.06	0.0002	0.0003	0.0021

2.4 Survey Results – Malahide Road

2.4.1 Location AVML006

Table 15 presents the results of vibration values measured during each 1 minute sample period at this location with periods during a bus or HGV drive by noted.

Table 15: Vibration Monitoring Results at ANML006

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$			Notes
	X	Y	Z	X	Y	Z	
11:23	0.03	0.03	0.07	0.0002	0.0002	0.0020	
11:24	0.03	0.02	0.06	0.0002	0.0001	0.0018	
11:25	0.03	0.03	0.10	0.0002	0.0002	0.0030	Bus
11:26	0.02	0.02	0.06	0.0002	0.0002	0.0015	HGV
11:27	0.03	0.03	0.07	0.0002	0.0002	0.0030	
11:28	0.02	0.02	0.05	0.0001	0.0001	0.0019	
11:29	0.05	0.03	0.08	0.0002	0.0002	0.0033	Bus
11:30	0.04	0.16	0.17	0.0002	0.0008	0.0027	HGV
11:31	0.02	0.02	0.03	0.0001	0.0001	0.0017	
11:32	0.04	0.05	0.07	0.0002	0.0002	0.0029	HGV
11:33	0.03	0.03	0.05	0.0002	0.0002	0.0020	
11:34	0.02	0.02	0.04	0.0002	0.0001	0.0015	Bus
11:35	0.04	0.04	0.13	0.0002	0.0002	0.0050	HGV
11:36	0.02	0.02	0.04	0.0001	0.0002	0.0015	
11:37	0.02	0.02	0.05	0.0002	0.0002	0.0020	Bus
11:38	0.02	0.02	0.03	0.0001	0.0001	0.0014	
11:39	0.04	0.03	0.10	0.0002	0.0002	0.0037	
11:40	0.03	0.04	0.12	0.0002	0.0002	0.0026	
11:41	0.07	0.06	0.15	0.0003	0.0002	0.0056	
11:42	0.05	0.03	0.11	0.0002	0.0002	0.0040	
11:43	0.04	0.04	0.05	0.0002	0.0002	0.0023	HGV
11:44	0.03	0.08	0.08	0.0002	0.0004	0.0021	
11:45	0.03	0.03	0.05	0.0002	0.0002	0.0025	HGV
11:46	0.04	0.04	0.06	0.0002	0.0002	0.0027	HGV
11:47	0.02	0.03	0.04	0.0001	0.0002	0.0012	
11:48	0.04	0.04	0.10	0.0003	0.0002	0.0036	
11:49	0.06	0.04	0.08	0.0003	0.0002	0.0028	
11:50	0.03	0.02	0.05	0.0002	0.0002	0.0020	
11:51	0.03	0.04	0.05	0.0002	0.0003	0.0021	
11:52	0.04	0.05	0.21	0.0003	0.0003	0.0053	
Maximum all traffic	0.07	0.16	0.17	0.0003	0.0008	0.0056	
Maximum bus	0.05	0.03	0.10	0.0002	0.0002	0.0033	

2.4.2 Location AVML007

Table 16 presents the results of vibration values measured during each 1 minute sample period at this location with periods during a bus or HGV drive by noted.

Table 16: Vibration Monitoring Results at ANML007

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$			Notes
	X	Y	Z	X	Y	Z	
11:55	0.03	0.02	0.04	0.0002	0.0001	0.0011	HGV
11:56	0.03	0.04	0.03	0.0002	0.0002	0.0011	
11:57	0.02	0.06	0.06	0.0002	0.0003	0.0011	
11:58	0.03	0.03	0.02	0.0002	0.0002	0.0004	
11:59	0.02	0.03	0.03	0.0001	0.0002	0.0008	
12:00	0.02	0.02	0.02	0.0001	0.0001	0.0005	
12:01	0.02	0.03	0.02	0.0001	0.0002	0.0005	
12:02	0.03	0.02	0.03	0.0002	0.0002	0.0009	
12:03	0.03	0.03	0.02	0.0002	0.0002	0.0008	
12:04	0.02	0.03	0.02	0.0001	0.0001	0.0004	
12:05	0.02	0.02	0.03	0.0002	0.0002	0.0011	
12:06	0.03	0.03	0.02	0.0002	0.0002	0.0006	Bus
12:07	0.02	0.05	0.05	0.0001	0.0002	0.0008	Bus
12:08	0.02	0.02	0.02	0.0002	0.0001	0.0007	Bus
12:09	0.02	0.02	0.03	0.0001	0.0002	0.0008	
12:10	0.02	0.03	0.02	0.0002	0.0002	0.0005	Bus
12:11	0.02	0.02	0.02	0.0001	0.0002	0.0009	
12:12	0.02	0.02	0.02	0.0001	0.0002	0.0003	
12:13	0.02	0.02	0.02	0.0001	0.0001	0.0007	Bus
12:14	0.02	0.02	0.02	0.0001	0.0002	0.0009	
12:15	0.02	0.02	0.02	0.0001	0.0001	0.0008	
12:16	0.02	0.02	0.02	0.0001	0.0001	0.0005	
12:17	0.02	0.02	0.02	0.0001	0.0001	0.0005	Bus
12:18	0.02	0.03	0.03	0.0002	0.0002	0.0008	
12:19	0.03	0.03	0.03	0.0002	0.0002	0.0010	
12:20	0.02	0.02	0.02	0.0002	0.0002	0.0009	Bus
12:21	0.02	0.02	0.04	0.0001	0.0001	0.0012	
12:22	0.02	0.03	0.03	0.0001	0.0002	0.0010	
Maximum all traffic	0.03	0.06	0.06	0.0002	0.0003	0.0012	
Maximum bus	0.03	0.05	0.05	0.0002	0.0002	0.0009	

2.4.3 Location AVML008

Table 17 presents the results of vibration values measured during each 1 minute sample period at this location with periods during a bus or HGV drive by noted.

Table 17: Vibration Monitoring Results at ANML008

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$			Notes
	X	Y	Z	X	Y	Z	
12:31	0.02	0.02	0.06	0.0001	0.0001	0.0004	Bus
12:32	0.02	0.06	0.08	0.0001	0.0003	0.0009	
12:33	0.02	0.03	0.04	0.0001	0.0002	0.0012	Bus
12:34	0.02	0.02	0.02	0.0001	0.0001	0.0004	HGV
12:35	0.02	0.02	0.04	0.0002	0.0002	0.0010	
12:36	0.02	0.02	0.02	0.0002	0.0002	0.0006	
12:37	0.02	0.02	0.02	0.0001	0.0001	0.0003	
12:38	0.02	0.03	0.03	0.0001	0.0002	0.0005	
12:39	0.02	0.03	0.02	0.0001	0.0002	0.0005	
12:40	0.03	0.03	0.02	0.0002	0.0002	0.0006	
12:41	0.04	0.03	0.02	0.0003	0.0002	0.0005	
12:42	0.03	0.02	0.03	0.0002	0.0001	0.0013	Bus
12:43	0.06	0.07	0.18	0.0003	0.0003	0.0057	
12:44	0.01	0.02	0.02	0.0001	0.0001	0.0004	Bus
12:45	0.02	0.03	0.05	0.0001	0.0002	0.0015	
12:46	0.02	0.02	0.03	0.0001	0.0001	0.0010	
12:47	0.02	0.03	0.03	0.0001	0.0001	0.0007	HGV
12:48	0.02	0.03	0.03	0.0001	0.0002	0.0010	HGV
12:49	0.02	0.02	0.02	0.0001	0.0001	0.0005	
12:50	0.02	0.02	0.02	0.0001	0.0001	0.0004	
12:51	0.02	0.02	0.02	0.0001	0.0002	0.0004	
12:52	0.02	0.02	0.02	0.0001	0.0002	0.0005	Bus
12:53	0.02	0.02	0.03	0.0001	0.0002	0.0009	
12:54	0.02	0.03	0.04	0.0001	0.0002	0.0012	
12:55	0.02	0.02	0.02	0.0001	0.0002	0.0003	
12:56	0.04	0.05	0.23	0.0002	0.0003	0.0056	HGV
12:57	0.02	0.03	0.05	0.0001	0.0002	0.0017	Bus
12:58	0.02	0.02	0.04	0.0001	0.0001	0.0012	
12:59	0.02	0.03	0.02	0.0001	0.0002	0.0006	
Maximum all traffic	0.06	0.07	0.23	0.0003	0.0003	0.0057	
Maximum bus	0.03	0.03	0.06	0.0002	0.0002	0.0017	

2.4.4 Location AVML009

Table 18 presents the results of vibration values measured during each 1 minute sample period at this location with periods during a bus or HGV drive by noted.

Table 18: Vibration Monitoring Results at ANML009

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$			Notes
	X	Y	Z	X	Y	Z	
13:05	0.03	0.02	0.05	0.0001	0.0001	0.0012	
13:06	0.02	0.04	0.03	0.0002	0.0001	0.0011	Bus
13:07	0.04	0.05	0.08	0.0002	0.0002	0.0028	HGV
13:08	0.04	0.05	0.06	0.0002	0.0002	0.0019	
13:09	0.04	0.03	0.03	0.0002	0.0002	0.0011	
13:10	0.03	0.04	0.04	0.0002	0.0001	0.0012	
13:11	0.03	0.04	0.04	0.0002	0.0001	0.0011	
13:12	0.02	0.03	0.04	0.0002	0.0001	0.0012	Bus
13:13	0.03	0.06	0.04	0.0002	0.0003	0.0013	
13:14	0.03	0.04	0.03	0.0002	0.0002	0.0012	Bus
13:15	0.04	0.04	0.04	0.0002	0.0003	0.0014	Bus
13:16	0.04	0.04	0.09	0.0002	0.0001	0.0028	HGV
13:17	0.06	0.06	0.05	0.0002	0.0002	0.0016	
13:18	0.03	0.04	0.05	0.0002	0.0002	0.0016	Bus
13:19	0.02	0.03	0.03	0.0001	0.0001	0.0008	
13:20	0.04	0.04	0.03	0.0002	0.0002	0.0011	Bus
13:21	0.03	0.03	0.03	0.0001	0.0001	0.0011	Bus
13:22	0.04	0.04	0.09	0.0002	0.0002	0.0030	
13:23	0.03	0.03	0.03	0.0001	0.0001	0.0013	
13:24	0.02	0.03	0.05	0.0001	0.0002	0.0012	HGV
13:25	0.03	0.03	0.05	0.0002	0.0002	0.0014	
13:26	0.03	0.05	0.05	0.0002	0.0003	0.0015	Bus
13:27	0.03	0.04	0.04	0.0002	0.0002	0.0012	
13:28	0.02	0.04	0.04	0.0001	0.0002	0.0008	Bus
13:29	0.04	0.05	0.04	0.0003	0.0003	0.0022	
13:30	0.03	0.03	0.08	0.0002	0.0002	0.0022	
13:31	0.04	0.04	0.03	0.0002	0.0002	0.0011	
13:32	0.02	0.02	0.04	0.0001	0.0001	0.0011	
13:33	0.02	0.03	0.04	0.0002	0.0002	0.0014	
13:05	0.03	0.02	0.05	0.0001	0.0001	0.0012	
Maximum all traffic	0.06	0.06	0.09	0.0003	0.0003	0.0030	
Maximum bus	0.04	0.05	0.05	0.0002	0.0003	0.0016	

2.5 References

ISO 1996-1:2016 Acoustics - Description, measurement, and assessment of environmental noise. Part 1: Basic quantities and assessment procedures (ISO 2016)

ISO 1996-2:2017 - Description, measurement, and assessment of environmental noise - Part 2: Determination of sound pressure levels (ISO 2017)

Transport Infrastructure Ireland (TII) (previously National Roads Authority (NRA)) Guidelines for the Treatment of Noise and Vibration in National Road Schemes, Revision 1 (TII 2004)

The UK Department of Transport Calculation of Road Traffic Noise (UK Department of Transport 1998)

British Standard Institute (BSI) British Standard (BS) 7385: 1990: Evaluation and measurement for vibration in buildings. Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings. (BSI 1990)

BS 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings. Part 1 Vibration sources other than blasting (BSI 2008)

Directives and Legislation

S.I. No. 140/2006 – European Communities (Environmental Noise) Regulations 2006

3. Calibration Certificates for Monitoring Equipment

3.1 Rion NL-52 S/N 1076328

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

UKAS CALIBRATION
0653

Date of Issue: 15 August 2018

Certificate Number: UCRT18/1836

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

Approved Signatory

J. Harriman

Customer	AWN Consulting Limited The Tecpro Building IDA Business and Technology Park Dublin 17 Ireland
Order No.	1869
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-52	01076328
Rion	Firmware		1.9
Rion	Pre Amplifier	NH-25	76545
Rion	Microphone	UC-59	12271
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 13 August 2018 ANV Job No. UKAS18/08513

Date Calibrated 15 August 2018

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*
	Initial Calibration		

CERTIFICATE OF CALIBRATION	Certificate Number UCRT18/1836
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		06 August 2018	
Calibrator cert. number		UCRT18/1784	
Calibrator cal cert issued by		0653	
Calibrator SPL @ STP		93.99 dB	Calibration reference sound pressure level
Calibrator frequency		1001.97 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	22.84	22.87	± 0.30 °C
Humidity	49.8	49.7	± 3.00 %RH
Ambient Pressure	100.67	100.63	± 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		
	11.5	dB	UR	15.5	dB	UR	21.4	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: A Patel R 1

Additional Comments
None

3.2 Rion NL-52 S/N 998413

ANV MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

ilac-MRA UKAS CALIBRATION 0653

Date of Issue: 22 January 2020 **Certificate Number: UCRT20/1095**

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

Approved Signatory

K. Mistry

Customer	AWN Consulting The Tecpro Building IDA Business and Technology Park Clonshaugh Dublin 17
Order No.	AWNC150120QTE
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	00998413
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	98627
	Rion	Microphone	UC-59	15920
	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	17 January 2020	ANV Job No.	UKAS20/01036
Date Calibrated	22 January 2020		

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*
	Initial Calibration		

CERTIFICATE OF CALIBRATION

Certificate Number
UCRT20/1095

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		21 January 2020	
Calibrator cert. number		UCRT20/1082	
Calibrator cal cert issued by		0653	
Calibrator SPL @ STP	93.98	dB	Calibration reference sound pressure level
Calibrator frequency	1001.97	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	22.18	22.19	± 0.30 °C
Humidity	38.7	37.6	± 3.00 %RH
Ambient Pressure	102.72	102.74	± 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		
	11.7	dB	UR	16.3	dB	UR	23.2	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 2

Additional Comments The results on this certificate only relate to the items calibrated as identified above.
None

3.3 Bruel and Kjaer 2250 3028635

Brüel & Kjær

The Calibration Laboratory
Skodsborgvej 307, DK-2850 Nærum, Denmark

DANAK
CAL Reg.No. 307
Member of EA MLA

CERTIFICATE OF CALIBRATION

No: CDK1907817 Page 1 of 12

CALIBRATION OF

Sound Level Meter:	Brüel & Kjær Type 2250	No: 3028635	Id: -
Microphone:	Brüel & Kjær Type 4189	No: 3196319	
Preamplifier:	Brüel & Kjær Type ZC-0032	No: 29471	
Software version:	BZ7222 Version 4.7.5	Pattern Approval:	PTB1.63-4093056 / 1.63-4093058
Instruction manual:	BE1712-22		

CUSTOMER

AWN Consulting Ltd
Tecpro House
Clonshaugh Business & Technology Park
,
D17 NX50 Dublin
Ireland

CALIBRATION CONDITIONS

Preconditioning: 4 hours at 23°C ± 3°C

Environment conditions: *See actual values in **Environmental conditions** sections.*

SPECIFICATIONS

The Sound Level Meter Brüel & Kjær Type 2250 has been calibrated in accordance with the requirements as specified in IEC 61672-1:2013 class 1. Procedures from IEC 61672-3:2013 were used to perform the periodic tests. The accreditation assures the traceability to the international units system SI.

PROCEDURE

The measurements have been performed with the assistance of Brüel & Kjær Sound Level Meter Calibration System 3630 with application software type 7763 (version 8.0 - DB: 8.00) by using procedure B&K proc 2250, 4189 (IEC 61672:2013).

RESULTS

Calibration Mode: **Calibration as received.**

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$ providing a level of confidence of approximately 95 %. The uncertainty evaluation has been carried out in accordance with EA-4/02 from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the device under calibration.

Date of calibration: 2019-10-03

Date of issue: 2019-10-03

Lene Petersen
Calibration Technician

Susanne Jørgensen
Approved Signatory

3.4 Bruel and Kjaer 2250L 3008402

ANV MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

0653

Date of Issue: 04 November 2019

Certificate Number: UCRT19/2218

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 3 Pages

Approved Signatory

K. Mistry

CUSTOMER	AWN Consulting Limited The Tecpro Building IDA Business and Technology Park Clonshaugh Dublin 17 Ireland
ORDER No	DOD/19/Cal013 Job No UKAS19/11718
DATE OF RECEIPT	01 November 2019
PROCEDURE	Calibration Engineer's Handbook, section 25: periodic testing of sound level meters to IEC 61672-3:2006 (BS EN 61672-3:2006) as modified by UKAS TPS 49 Edition 2:June 2009
IDENTIFICATION	Sound level meter Brüel & Kjær type 2250-L serial No 3008402 connected via a preamplifier type ZC 0032 serial No 22882 to a half-inch microphone type 4950 serial No 3016830. Associated calibrator Brüel & Kjær type 4231 serial No 2263026 with a one-inch housing and adapter type UC 0210 for half-inch microphone.
CALIBRATED ON	04 November 2019
PREVIOUS CALIBRATION	Calibrated on 16 October 2017, Certificate No. UCRT17/1897 issued by this laboratory.

CERTIFICATE OF CALIBRATION

UKAS ACCREDITED CALIBRATION LABORATORY No 0653

Certificate No UCRT19/2218

The sound level meter was set up using the type 4231 sound calibrator supplied; it was set to frequency weighting A, and initially read 94.1 dB. It was then adjusted to read 93.9 dB (corresponding to 93.9 dB at standard atmospheric pressure). This reading was derived from Calibration Certificate no. UCRT19/2217 supplied by this laboratory and manufacturers' information on the free-field response of the sound level meter. The calibration check frequency was 1kHz. The final microphone sensitivity calculated and stored by the instrument was 45.25 mV/Pa.

Procedures from IEC 61672-3:2006 (BS EN 61672-3:2006) as modified by UKAS TPS 49 Edition 2:June 2009 were used to perform the periodic tests.

RESULTS

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

The self-generated noise recorded with the microphone replaced by the electrical input device was:

13.4 dB (A) 13.8 dB (C) 19.5 dB (Z)

The environmental conditions recorded at the start and end of testing were:

Start: 23 to 24 °C, 31 to 41 %RH and 97.2 to 97.3 kPa
End: 24 to 25 °C, 34 to 44 %RH and 97.2 to 97.3 kPa

Technical information including adjustment data specified in the manufacturers' Instruction Manual BE 1774-11 (2007) and User Manual BE 1766 has been used to carry out this verification. These data include manufacturer-specified uncertainties.

Publicly-available evidence has been found that the B&K 2250-L sound level meter design has successfully undergone pattern evaluation in accordance with IEC 61672-2:2002 (BS EN 61672-2:2003) by Physikalisch-Technische Bundesanstalt (PTB), an independent testing organisation responsible for pattern approvals.

All measurement data are held at ANV Measurement Systems for a period of at least six years.

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.

CERTIFICATE OF CALIBRATION

UKAS ACCREDITED CALIBRATION LABORATORY No 0653

Certificate No UCRT19/2218

NOTES

Any opinions or interpretations which may be expressed in the following notes are not UKAS Accredited.

1 All tests were carried out in "Broad Band".

2 Windscreen correction was set to "None", soundfield to "Free-field" and microphone to "4950".

3 No suitable microphone frequency response information was supplied with the instrument. It was therefore measured by this laboratory using the electrostatic actuator method. This response in isolation is not UKAS Accredited.

4 It was noted that in order to obtain the correct A-weighted response to the sound calibrator, the relevant software setting in the meter had to be changed from '4231' to 'custom' with the appropriate calibration level entered.

5 The electrical tests have been carried out with the instrument set for the nominal microphone sensitivity, as specified in the Instruction Manual. This may mean that the instrument has a slightly different linearity range when in normal use.

6 Typical case reflection factors specified by the manufacturer have been used for this verification.

The instrument was running on hardware version 4.0

The instrument firmware settings were:

Module i.d.	Function	Version	Active?	Licenced?	Template used?
BZ 7130	SLM	4.7.5	Y	Y	Y
BZ 7131	Octave analysis	4.7.5	Y	N	N/A
BZ 7132	1/3-oct analysis	4.7.5	Y	Y	N/A
BZ 7133	Logging	4.7.5	Y	Y	N/A
BZ 7226	Signal Recording Option	4.7.5	Y	N	N/A
BZ 7231	Tone Assessment	4.7.5	Y	N	N/A
BZ 7232	Noise Monitoring Software	4.7.5	Y	N	N/A
BZ	N/A	N/A	N/A	N/A	N/A
BZ	N/A	N/A	N/A	N/A	N/A
BZ	N/A	N/A	N/A	N/A	N/A

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

END R 3

3.5 Rion VM-56 (S/N 680043)

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

Date of Issue: 01 November 2019 **Certificate Number: TCRT19/1825**

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

Approved Signatory

K. Mistry

Client	AWN Consulting Limited The Tecpro Building, IDA Business & Technology Park, Clonshaugh Dublin 17 Ireland
Purchase Order No.	DOD/19/Cal03
Instrument	Rion VM-56 Tri-Axial Vibration Meter
Serial No.	00680043
Accelerometer Type	VM-56
Accelerometer Serial No.	80047
Program	2.0
Client Asset No.	N/A
Procedure ID.	VM-56 Issue 1
Job Number	TRAC19/11477
Date of Calibration	01 Nov 2019
Previous Cert. number	N/A
Date of Previous Cert.	N/A
Rig Number	6
Kit Number	24
Calibration Status	**Passed Calibration**

This calibration is traceable to National Standards. ANV Measurement Systems sources used to perform calibrations are calibrated at the National Physical Laboratory or by UKAS laboratories accredited for the purpose.

The performance of the system (the meter, accelerometer) was found to be within the manufacturer's specification.

Comment
This certificate reports recorded values for the instrument 'As Received'.

CERTIFICATE OF CALIBRATION

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Environment
The ambient environmental conditions at the time of the calibration were;
Temperature: 22.9 ± 1°C, Humidity: 40 ± 5%RH, Atmospheric pressure 98.2 ± 1 kPa

Test results
Each accelerometer axis was mounted co-axially with a Rion LS-10C servo accelerometer, and tests conducted for the dynamic range, PPV linearity and frequency response of the complete system. Additional electrical tests were carried out on the amplitude linearity of the instrument.

PPV linearity response for the complete system at 16 Hz With PV-83CW serial No. 80047
Weightings for all channels turned OFF

Target Vel. mm/s	Actual Vel. mm/s	Indicated (X) mm/s	Error (X) %	Indicated (Y) mm/s	Error (Y) %	Indicated (Z) mm/s	Error (Z) %
0.50	0.51	0.57	11.56	0.55	7.65	0.54	5.69
1.00	1.02	1.09	6.67	1.08	5.69	1.06	3.73
2.50	2.55	2.67	4.51	2.66	4.12	2.60	1.77
5.00	5.11	5.31	3.93	5.30	3.73	5.18	1.38
10.00	10.13	10.59	4.50	10.43	2.92	10.35	2.13
20.00	20.27	21.24	4.80	21.03	3.76	20.61	1.69

Permitted tolerance ± 10% ± 1 LSD (Least Significant Digit).

Linearity errors in dB measured electrically at 40 Hz
Weightings for all channels turned OFF
Level changes in dB; reading error in dB given for each axis. "m/s²" is actual reading in m/s².

1 m/s² Range

Level dB	Error (X) dB	m/s² (X)	Error (Y) dB	m/s² (Y)	Error (Z) dB	m/s² (Z)
0	REF	0.98154	REF	0.98129	REF	0.98130
-20	-0.01	0.09805	-0.01	0.09802	-0.01	0.09803
-40	-0.02	0.00979	-0.02	0.00979	-0.02	0.00979
-60	-0.10	0.00097	-0.10	0.00097	-0.10	0.00097
-66	-0.03	0.00049	-0.21	0.00048	-0.03	0.00049
-72	-0.23	0.00024	-0.23	0.00024	-0.23	0.00024

Permitted tolerance ±1.0 dB.

10 m/s² Range

Level dB	Error (X) dB	m/s² (X)	Error (Y) dB	m/s² (Y)	Error (Z) dB	m/s² (Z)
20	-0.03	9.79122	-0.03	9.75526	-0.03	9.73534
0	REF	0.98208	REF	0.97857	REF	0.97679
-20	-0.01	0.09808	-0.01	0.09775	-0.01	0.09758
-30	-0.01	0.03102	-0.03	0.03085	-0.06	0.03067
-40	0.04	0.00987	-0.02	0.00976	0.02	0.00979
-52	-0.31	0.00238	0.69	0.00266	-0.01	0.00245

Permitted tolerance ±1.0 dB.

CERTIFICATE OF CALIBRATION

Certificate Number
TCRT19/1825
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Frequency Responses For Complete System

Measured on the 1 m/s^2 range with weightings as indicated in the table and PV-83CW serial No. 80047

Frequency Hz	Applied Acc. m/s^2	X (Wd) rms m/s^2	Error X %	VDV (X) m/s$^{1.75}$	Error X %
3.981	0.285	0.15654	5.4	0.30765	5.3
5.012	0.355	0.15445	5.2	0.30359	5.1
6.310	0.355	0.12187	5.1	0.23974	5.0
7.943	0.355	0.09586	4.5	0.18849	4.4
10.00	0.355	0.07622	4.9	0.14987	4.8
12.59	0.355	0.06052	5.3	0.11912	5.3
15.85	0.355	0.04836	6.2	0.09515	6.2
19.95	0.550	0.06014	7.3	0.11834	7.3

Frequency Hz	Applied Acc. m/s^2	Y (Wd) rms m/s^2	Error Y %	VDV (Y) m/s$^{1.75}$	Error Y %
3.981	0.285	0.15640	5.3	0.30743	5.2
5.012	0.355	0.15372	4.7	0.30199	4.5
6.310	0.355	0.12149	4.7	0.23878	4.6
7.943	0.355	0.09627	5.0	0.18928	4.9
10.00	0.355	0.07622	4.9	0.14987	4.8
12.59	0.355	0.06054	5.3	0.11907	5.3
15.85	0.355	0.04850	6.5	0.09539	6.5
19.95	0.550	0.06064	8.2	0.11932	8.2

Frequency Hz	Applied Acc. m/s^2	Z (Wb) rms m/s^2	Error Z %	VDV (Z) m/s$^{1.75}$	Error Z %
3.981	0.285	0.26307	3.0	0.52192	3.8
5.012	0.355	0.37779	2.4	0.74853	3.1
6.310	0.355	0.38731	2.1	0.76723	2.7
7.943	0.355	0.37632	2.0	0.74338	2.4
10.00	0.355	0.35641	1.6	0.70262	1.7
12.59	0.355	0.32928	1.2	0.64883	1.3
15.85	0.355	0.29668	1.3	0.58400	1.3
19.95	0.550	0.39872	0.8	0.78497	0.8
25.12	0.550	0.33640	3.3	0.66184	3.3
31.62	0.550	0.27597	2.9	0.54310	2.9
39.81	0.550	0.21843	1.0	0.42982	1.0
50.12	0.550	0.17703	3.4	0.34836	3.3
63.10	0.550	0.13695	3.8	0.26950	3.8
79.43	0.550	0.10077	4.1	0.19832	4.1

Tolerance required @ 4 Hz to 63 Hz +12%/-11% ; @ 80 Hz +26%/-21%

All results meet the manufacturer's specification.

END OF CALIBRATION **CALIBRATED BY :- A. Lloyd**

4. Unattended Monitoring Equipment Set Up

Location	Equipment Set up
CBC0016UNML001 In external roof garden on first floor of residential NSL in Capital Dock, Britain Quay facing east towards River Dodder.