Appendix A9.1
Noise & Vibration Survey

Contents

Appendix A9.1: 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 Belfield / Blackrock to City Centre Bus Corridor Scheme (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

A full description of the Proposed Scheme can be found in Chapter 4 (Proposed Scheme Description) in Volume 2 of this EIAR. The assessment study area is split into five geographical areas. The range of noise and vibration sensitive locations along the Proposed Scheme for the five geographical sections are discussed in Table 1.

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

Geographical Zone	Description of Study Area
Stradbrook Road to Booterstown Avenue	The key noise and vibration sensitive receptors within this section are residential properties within 50m to 100m of the alignment, in particular those that have the road alignment moving closer to the properties by greater than 5m. Sensitive receptors also include Willow Park School, Blackrock College, Blackrock Clinic, The Alzheimer Society of Ireland and Blackrock Hospice.
Booterstown Avenue to Nutley Lane	The key noise and vibration sensitive receptors within this section are residential properties along Merrion Road and Nutley Lane within 50m of the road edge. St Mary's Nursing Home and St. Vincent's University Hospital
Merrion Road (Nutley Lane to Ballsbridge)	The key noise and vibration sensitive receptors within this section include St. Vincent's University Hospital, St. Michael's College, residential properties within 20m to 100m of the Proposed Scheme and embassy buildings.
Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)	The key noise and vibration sensitive receptors within this section include Sandymount Park Educate Together Secondary school, Home Instead Senior Care Home, Pembroke Montessori, Scoil Chaitríona Baggot Street and residential properties are located within 20m to 100m of the Proposed Scheme in this geographical Section.
Nutley Lane (R138 to Merrion Road)	The key noise and vibration sensitive receptors within this section include St. Vincent's University Hospital and residential properties within 20m to 100m.

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. Attended baseline noise measurements were made at a total of eighteen locations along the length of the Proposed Scheme to inform the assessment.

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 Stradbrook Road to Booterstown Avenue

A total of six attended monitoring 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 – Stradbrook Road to Booterstown Avenue

Location	Description of Survey Location
Attended Monitoring Locations	
CBC1415ANML010	On footpath to west of St Vincent's Park, in line with façade of residential façade facing R113, surrounded by residential buildings and adjacent to R113 Temple Hill. Located approximately 7m fromR113 Temple Hill Road edge.
CBC1415ANML011	On footpath to south of R113 Temple Hill / Temple Park Avenue junction, in line with residential facades facing onto R113 Temple Hill. Located approximately 10m from R113 road edge.
CBC1415ANML012	On footpath to north of R118 Rock Road / Ben Inagh Park junction, in line with residential facades facing onto R118 Rock Road. Located approximately 3m from R118 road edge.
CBC1415ANML013	In green space to south of Castledawson housing estate, in line with closest façade of Blackrock eye clinic to west, Located approximately 45m from R118 Rock Road.
CBC1415ANML014	At the gate lodge entrance to Blackrock College, located approximately 15m from R118 Rock Road.
CBC1415ANML015	On footpath to west of R118 Rock Road / Booterstown Avenue junction, in line with façade of NSLs facing onto R118 Rock Road. Located approximately 15m from R118 road edge.

1.2.2.2 Booterstown Avenue to Nutley Lane

A total of three attended monitoring locations were surveyed within this study area. The location reference and a description of survey positions are included in Table 3.

Table 3: Noise Monitoring Locations – Booterstown Avenue to Nutley Lane

Location	Description of Survey Location
Attended Monitoring Locations	
CBC1415ANML016	On footpath to north of Landaff Terrace, in line with commercial façades facing onto R118 Merrion Road. Located approximately 18m from R118 road edge.
CBC1415ANML017	Located at entrance to a car park between residential facades to east of R118 Merrion Road / Estate Avenue junction. Located approximately 10m from R118 road edge.
CBC1415ANML018	On footpath to east of R118 Merrion Road / Herbert Avenue junction, in line with residential facades facing onto R118 Merrion Road. Located approximately 13m from R118 road edge.

1.2.2.3 Merrion Road - Nutley Lane to Ballsbridge

A total of three attended monitoring 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 – Merrion Road - Nutley Lane to Ballsbridge

Location	Description of Survey Location
Attended Monitoring Locations	
CBC1415ANML004	On footpath to south of R118 Merrion Road / Merrion View Avenue junction Located approximately 15m from R118 road edge.
CBC1415ANML005	On footpath to south of R118 Merrion Road / Merlyn Park junction, in line with residential facades facing onto R118 Merrion Road. Located approximately 15m from R118 road edge.
CBC1415ANML006	On footpath to south of R118 Merrion Road / Simmonscourt Road, in line with hotel facades facing into R118 Merrion Road. Located approximately 65m from R118 road edge.

1.2.2.4 Ballsbridge to Merrion Square

A total of three attended monitoring locations were surveyed within this study area. The location reference and a description of survey positions are included in Table 5.

Table 5: Noise Monitoring Locations – Ballsbridge to Merrion Square

Location	Description of Survey Location
Attended Monitoring Locations	
CBC1415ANML007	On footpath to east of R816 Pembroke Road / Wellington Road junction, in line with façade of terraced houses facing onto R816 Pembroke Road. Located approximately 35m from road edge.

Location	Description of Survey Location
CBC1415ANML008	On footpath to east of R816 Pembroke Road / Eastmoreland Place junction, in line with facades of NSLs facing R816 Pembroke Road. Located approximately 35m from R816 road edge.
CBC1415ANML009	On footpath to north of R816 Baggot Street Lower / Herbert Place junction, in line with residential façade facing onto R816. Baggot Street Lower. Located approximately 7m from R816 road edge.

1.2.2.5 Nutley Lane - R138 to Merrion Road

A total of three attended monitoring locations were surveyed within this study area. The location reference and a description of survey positions are included in Table 6.

Table 6: Noise Monitoring Locations – Nutley Lane - R138 to Merrion Road

Location	Description of Survey Location
Attended Monitoring Locations	
CBC1415ANML001	In front garden of residential property along Nutley Lane, in line with façade. Located approximately 15m from Nutley Lane Road edge.
CBC1415ANML002	On footpath to west of Nutley Lane / Nutley Avenue junction, in line with residential facades lining Nutley Lane. Located approximately 20m from road edge.
CBC1415ANML003	On footpath to southwest of St. Vincent's University Hospital in line with hospital façade. Located approximately 90m from Nutley Lane.

1.2.3 Survey Periods

Attended noise surveys were undertaken between 21 July 2020 and 25 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 surveys were undertaken using either RION NL-52 and Bruel and Kjær 2250L sound level meters. The specific equipment details are summarised in Table 7.

Table 7: Noise Monitoring Equipment

Survey Type	Equipment	Serial Number	Calibration Date
Attended	Rion NL-52	186668	07/05/2020
		998413	22/01/2020
	Bruel and Kjær 2250L	3008402	04/11/2019

Calibration certificates of the monitoring equipment are included within Section 4.

The surveys were conducted by Jack Brennan and Alex Ryan, 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):

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

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 of the day periods of a year. The 12hr daytime period is between 07:00 and 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 and 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 and 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 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 x $L_{A10(18hr)}$ + 9.86 dB.

1.3 Survey Results

1.3.1 Stradbrook Road to Booterstown Avenue

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

Table 8: Attended Noise Survey Results for Stradbrook Road to Booterstown Avenue

Attended Location	Date	Start Time	Measured Noise Levels (dB re.2x10^{-5}Pa)			Derived L_{den}	Survey Notes
			L_{Aeq}	L_{A10}	L_{A90}		
CBC1415ANML010	24/07/2020	13:46	60	63	52	63	Road traffic along R113 Temple Hill, pedestrian conversations .
		14:22	60	63	53		Road traffic along R113 Temple Hill.
		14:57	59	63	53		Road traffic along R113 Temple Hill, car horn.
CBC1415ANML011	24/07/2020	13:29	69	71	60	69	Road traffic along R113 Temple Hill.
		14:03	66	70	57		
		14:40	66	70	58		Road traffic along R113 Temple Hill, car horns.
CBC1415ANML012	24/07/2020	10:49	74	78	57	76	Road traffic along R118 Rock Road, birdsong, pedestrian conversation.
		11:51	74	78	56		Road traffic along R118 Rock Road, birdsong.
		12:57	74	78	54		
CBC1415ANML013	25/09/2020	14:08	60	63	52	63	Road traffic along R118 Rock Road.
		14:48	61	64	55		
		15:04	61	64	54		
		15:45	59	62	51		
CBC1415ANML014	25/09/2020	13:28	70	73	58	72	Road traffic along R118 Rock Road.
		13:47	70	73	61		
		14:28	71	73	63		
		15:24	70	73	61		
CBC1415ANML015	24/07/2020	10:26	70	73	62	71	Road traffic along R118 Rock Road, car horn.
		11:31	70	72	64		Road traffic along R118 Rock Road.
		12:35	70	73	63		

1.3.2 Booterstown Avenue to Nutley Lane

The noise survey results recorded during the baseline surveys within this study area are presented in Table 9.

Table 9: Attended Noise Survey Results for Booterstown Avenue to Nutley Lane

Attended Location	Date	Start Time	Measured Noise Levels (dB re.2x10^{-5}Pa)			Derived L_{den}	Survey Notes
			L_{Aeq}	L_{A10}	L_{A90}		
CBC1415ANML016	24/07/2020	10:00	64	66	57	66	Road traffic along R118 Merrion Road, house alarm, car horn.
		11:09	64	67	57		Road traffic along R118 Merrion Road.
		12:13	64	66	57		
CBC1415ANML017	23/07/2020	13:53	62	66	53	65	Road traffic along R118 Merrion Road, car horn.
		14:52	61	65	54		Road traffic along R118 Merrion Road.
		15:49	61	65	52		Road traffic along R118 Merrion Road, car horn.
CBC1415ANML018	23/07/2020	14:12	66	70	54	69	Road traffic along R118 Merrion Road, pedestrian crossing beacon.
		15:10	65	69	54		
		16:07	66	70	53		

1.3.3 Merrion Road - Nutley Lane to Ballsbridge

The noise survey results recorded during the baseline surveys within this study area are presented in Table 10.

Table 10: Attended Noise Survey Results for Merrion Road - Nutley Lane to Ballsbridge

Attended Location	Date	Start Time	Measured Noise Levels (dB re.2x10^{-5}Pa)			Derived L_{den}	Survey Notes
			L_{Aeq}	L_{A10}	L_{A90}		
CBC1415ANML004	21/07/2020	13:47	65	68	55	67	Road traffic along R118 Merrion Road, car horn at 9 mins.
		14:49	64	68	50		Road traffic along R118 Merrion Road.
		15:55	63	67	54		
CBC1415ANML005	21/07/2020	13:29	63	67	49	66	Road traffic along R118 Merrion Road.
		14:31	63	67	49		Road traffic along R118 Merrion Road, aircraft.
		15:38	62	66	48		Road traffic along R118 Merrion Road, aircraft, children playing in garden.
CBC1415ANML006	21/07/2020	13:08	65	68	54	67	Road traffic along Simmonscourt Road and R118 Merrion Road.
		14:08	63	67	53		
		15:18	63	67	53		

1.3.4 Ballsbridge to Merrion Square

The noise survey results recorded during the baseline surveys within this study area are presented in Table 11.

Table 11: Attended Noise Survey Results for Ballsbridge to Merrion Square

Attended Location	Date	Start Time	Measured Noise Levels (dB re.2x10^{-5}Pa)			Derived L_{den}	Survey Notes
			L_{Aeq}	L_{A10}	L_{A90}		
CBC1415ANML007	21/07/2020	10:45	59	63	51	62	Road traffic along Wellington Road and R816 Pembrooke Road, birdsong (seagulls).
		11:41	59	62	52		Road traffic along Wellington Road and R816 Pembrooke Road, dog barking at 10 mins.
		12:38	61	61	52		Road traffic along Wellington Road and R816 Pembrooke Road.
CBC1415ANML008	21/07/2020	10:27	63	66	53	67	Road traffic along R816 Pembrooke Road, vehicle reverse beacon at 12 mins, birdsong (seagulls).
		11:23	63	68	53		Road traffic along R816 Pembrooke Road, car horn.
		12:19	63	67	54		Road traffic along R816 Pembrooke Road.
CBC1415ANML009	21/07/2020	10:05	64	68	55	67	Road traffic along Baggot Street Upper, birdsong (seagulls).
		11:04	65	68	56		Road traffic along Baggot Street Upper, car horn.
		12:00	65	68	54		Road traffic along Baggot Street Upper, car horns, pedestrian crossing beacon.

1.3.5 Nutley Lane - R138 to Merrion Road

The noise survey results recorded during the baseline surveys within this study area are presented in Table 12.

Table 12: Attended Noise Survey Results for Nutley Lane - R138 to Merrion 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}		
CBC1415ANML001	23/09/2020	12:11	55	58	47	60	Road traffic along Nutley Lane.
		12:30	56	59	47		
		13:19	57	60	50		
		15:07	56	59	51		
CBC1415ANML002	23/07/2020	13:32	59	63	49	63	Road traffic along Nutley Lane.
		14:32	59	63	52		Road traffic along Nutley Lane, conversation at 7 and 12 mins.
		15:29	62	63	52		Road traffic along Nutley Lane, siren at 6 mins, conversation at 14 mins.
CBC1415ANML003	23/09/2020	12:56	57	58	51	60	Road traffic along Nutley Lane, vehicles in St. Vincent's University Hospital car park, construction noise in distance
		13:46	57	60	50		
		14:02	56	59	50		
		14:43	59	61	53		

2. Baseline Vibration Monitoring

2.1 Introduction

This section includes the relevant survey details and results associated with 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 inform 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 Works.

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 13.

Table 13: 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 Image 1. The survey locations undertaken along the Malahide Road are illustrated in Image 2.

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

Image 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 4.

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 one 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 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 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 15 presents the results of vibration values associated with individual bus drive events by during the monitoring period at this location.

Table 15: 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 16 presents the results of vibration values associated with individual bus drive events by during the monitoring period at this location.

Table 16: 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 17 presents the results of vibration values associated with individual bus drive events by during the monitoring period at this location.

Table 17: 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

2.3.6 Location AVML005

Table 18 presents the results of vibration values associated with individual bus drive events by during the monitoring period at this location.

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

Table 19: 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	

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$			Notes
	X	Y	Z	X	Y	Z	
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 20 presents the results of vibration values measured during each one minute sample period at this location with periods during a bus or HGV drive by noted.

Table 20: 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	

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$			Notes
	X	Y	Z	X	Y	Z	
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 21 presents the results of vibration values measured during each one minute sample period at this location with periods during a bus or HGV drive by noted.

Table 21: 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	

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$			Notes
	X	Y	Z	X	Y	Z	
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 22 presents the results of vibration values measured during each one minute sample period at this location with periods during a bus or HGV drive by noted.

Table 22: 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	

Event Time	PPV, mm/s			$VDV_{,b}$, $m/s^{1.75}$			Notes
	X	Y	Z	X	Y	Z	
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	

3. References

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)

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

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

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

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)

Directives and Legislation

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

4. Calibration Certificates for Monitoring Equipment

4.1 Rion NL-52 S/N 186668

ANV MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

0653

Date of Issue: 07 May 2020

Certificate Number: UCRT20/1405

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.	RM/20/Cal019			
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator			
Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	00186668
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	76701
	Rion	Microphone	UC-59	12813
	Brüel & Kjær	Calibrator	4231	2205805
		Calibrator adaptor type if applicable		UC 0210
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	30 April 2020	ANV Job No.	UKAS20/04240	
Date Calibrated	07 May 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*
	20 April 2018	UCRT18/1436	0653

CERTIFICATE OF CALIBRATION

Certificate Number	
UCRT20/1405	
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	Customers Calibrator		
Calibrator adaptor type if applicable	UC 0210		
Calibrator cal. date	06 December 2019		
Calibrator cert. number	UCRT19/2333		
Calibrator cal cert issued by	0653		
Calibrator SPL @ STP	93.95	dB	Calibration reference sound pressure level
Calibrator frequency	999.97	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	23.24	23.17	± 0.30 °C
Humidity	35.0	37.5	± 3.00 %RH
Ambient Pressure	101.20	101.19	± 0.03 kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.0	dB	Adjusted indicated level	93.9	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		
	12.4	dB	UR	16.2	dB	UR	22.1	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.
Prior to calibration the instrument's main PCB was replaced and the meter was re-aligned.

4.2 Rion NL-52 S/N 998413

MEASUREMENT SYSTEMS

CERTIFICATE OF 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

Page 1 of 2 Pages

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

4.3 Bruel and Kjaer 2250L

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
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Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

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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

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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

4.4 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'.

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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/s^{2}" is actual reading in m/s^{2}.

1 m/s^{2} Range

Level dB	Error (X) dB	m/s^{2} (X)	Error (Y) dB	m/s^{2} (Y)	Error (Z) dB	m/s^{2} (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/s^{2} Range

Level dB	Error (X) dB	m/s^{2} (X)	Error (Y) dB	m/s^{2} (Y)	Error (Z) dB	m/s^{2} (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.

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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**