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Multi-Storey Carpark, Liverpool Hospital

Fortnightly Noise and Vibration Monitoring Report #3

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Attention To	ADCO Constructions Pty Ltd

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1 INTRODUCTION

Acoustic Logic has been engaged to conduct a noise and vibration monitoring service during the Stage 1 construction phase of the Liverpool Hospital Multi-Storey Carpark. The purpose of the noise and vibration monitoring service at the project site is to protect the nearest sensitive receivers being the Liverpool Hospital Brain Injury Unit situated adjacent from the construction site.

Noise and vibration monitoring has been conducted to alert of any potential noise or vibration exceedances caused by construction works occurring at the Stage 1 Multi-Storey Carpark construction site given the close proximity of the Brain Injury Unit.

This report provides the results of our unattended noise and vibration monitoring at the Brain Injury Unit adjacent to the construction site between the 26th February 2021 to the 12th March 2021.

2 SITE DESCRIPTION

The Brain Injury Unit is located along the north-eastern boundary of Liverpool Hospital and is the nearest sensitive receiver to the Stage 1 construction zone.

One (1) Acoustic Research Laboratories Pty Ltd noise logger along with one (1) ETM vibration monitor has been installed at the Liverpool Hospital Brain Injury Unit. The location of these monitors are as follows:

- **Noise Monitoring Location:** Located along the northern façade of the Brain Injury Unit (facing the construction site) situated within a small garden bed.
- **Vibration Monitor Location 1:** Located along the northern façade of the Brain Injury Unit (facing the construction site) with the geophone mounted directly to the façade of the building structure.

Refer to figure 1 below for an aerial photo of the project site. Figures 2 and 3 below provide photos of the installed noise and vibration monitors in all locations.

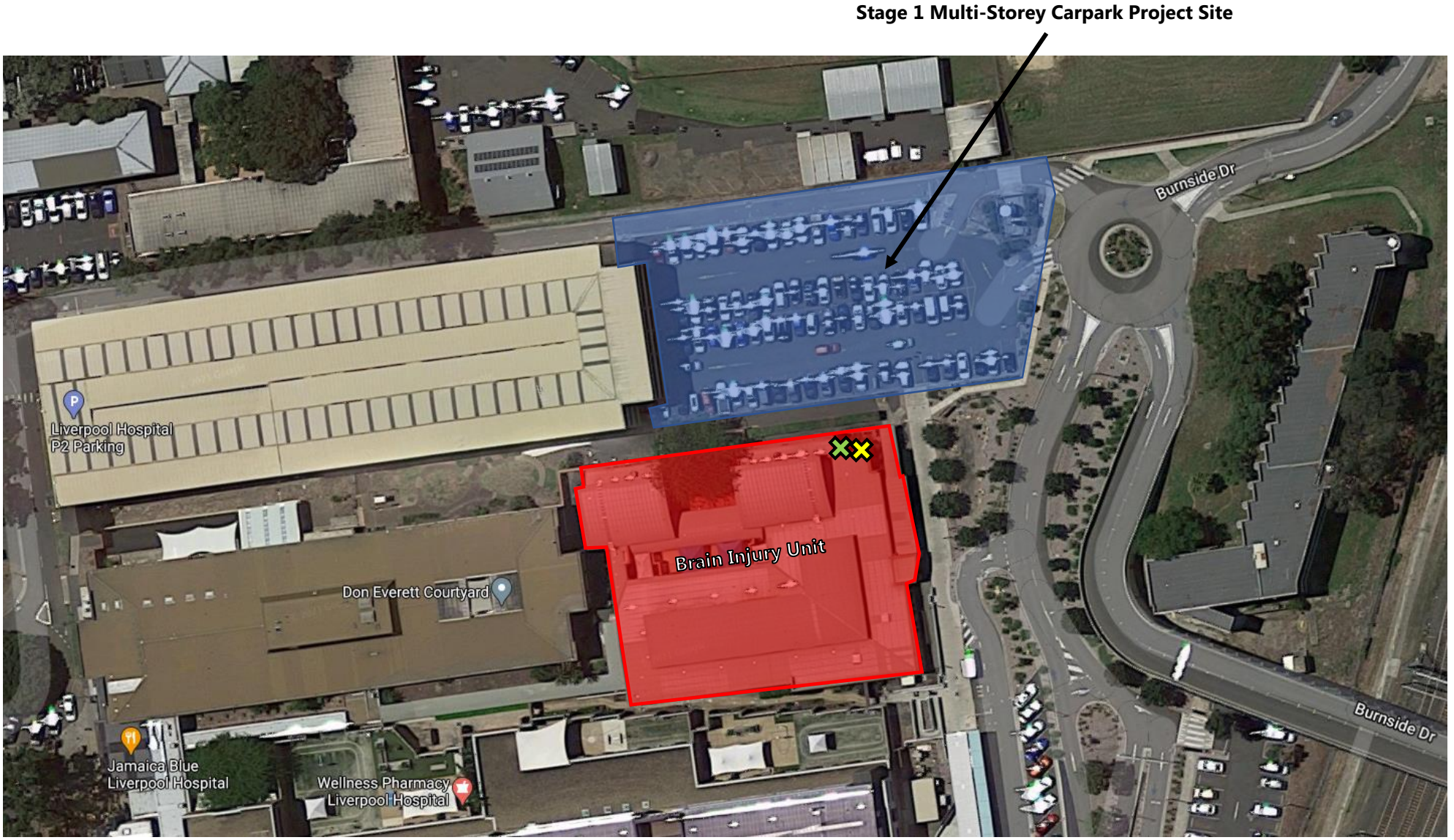


Figure 1: Aerial site map & monitoring locations

= **Noise Monitor Location**

= **Vibration Monitor Location**

Figure 2: Noise Monitor installed within Brain Injury Unit Garden Bed

Figure 3: Vibration Monitor installed along Brain Injury Unit Facade

2.1 MEASUREMENT EQUIPMENT

The equipment used to monitor noise emissions from the construction works consists of one (1) Acoustic Research Laboratories Pty Ltd noise logger. The logger was programmed to store 15-minute statistical noise levels throughout the monitoring period. The equipment was calibrated at the beginning and the end of each measurement using a Rion NC-73 calibrator; no significant drift was detected. All measurements were taken on A-weighted fast response mode.

2.2 NOISE MANAGEMENT LEVEL APPLICABLE TO THIS PROJECT

Table 3 of the ICNG outlines the following management noise levels to internal areas of hospital buildings:

Table 1 – Noise Management Level for Hospital Buildings (ICGN)

Space	Internal Management Level dB(A)$L_{eq\ (15\ min)}$
Within Hospital Wards and operating theatres	45

3 VIBRATION MONITORING

3.1 MEASUREMENT EQUIPMENT

The equipment used to monitor vibration emissions from the construction works are one (1) ETM vibration monitor with external geophones. The monitor was programmed with SMS messaging to alert of any vibration events exceeding the pre-defined warning level. The monitors were calibrated before being installed on the site.

3.2 VIBRATION CRITERIA APPLICABLE TO THIS PROJECT

As this office has been advised that the Brain Injury Unit of Liverpool Hospital contains wards and does not contain any sensitive medical equipment, the vibration monitoring data recorded at the façade of the Brain Injury Unit will be assessed against the continuous vibration criteria for residences of the Environmental Noise Management *'Assessing Vibration – A Technical Guideline'* 2006 Table C1.1 and the German Standard DIN 4150, *'Vibration in Buildings (1999-02)* which are detailed below.

Table C1.1 Criteria for exposure to continuous and impulsive vibration

		Assessment criteria					
		[1]rms acceleration (m/s^2) (& vib. accel. value) (dB re 10^{-6} m/s^2)		[2]rms velocity (mm/s) (& vib. velocity value) (dB re 10^{-6} mm/s)		[2]Peak velocity (mm/s)	
Place	**Time**	Preferred	Maximum	Preferred	Maximum	Preferred	Maximum
Continuous vibration							
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day- or night-time	0.0050 (74 dB)	0.010 (80 dB)	0.10 (100 dB)	0.20 (106 dB)	0.14	0.28
Residences	Daytime[3]	0.010 (80 dB)	0.020 (86 dB)	0.20 (106 dB)	0.40 (112 dB)	0.28	0.56
	Night-time	0.0070 (77 dB)	0.014 (83 dB)	0.14 (103 dB)	0.28 (109 dB)	0.20	0.40
Offices	Day- or night-time	0.020 (86 dB)	0.040 (92 dB)	0.40 (112 dB)	0.80 (118 dB)	0.56	1.1
Workshops	Day- or night-time	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)	1.1	2.2
Impulsive vibration							
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day- or night-time	0.0050 (74 dB)	0.010 (80 dB)	0.10 (100 dB)	0.20 (106 dB)	0.14	0.28
Residences	Daytime[3]	0.30 (110 dB)	0.60 (113 dB)	6.0 (136 dB)	12.0 (142 dB)	8.6	17.0
	Night-time	0.10 (100 dB)	0.20 (106 dB)	2.0 (126 dB)	4.0 (132 dB)	2.8	5.6
Offices	Day- or night-time	0.64 (116 dB)	1.28 (122 dB)	13.0 (142 dB)	26.0 (148 dB)	18.0	36.0
Workshops	Day- or night-time	0.64 (116 dB)	1.28 (122 dB)	13.0 (142 dB)	26.0 (148 dB)	18.0	36.0

1 Values derived from z-axis critical frequency range 4–8 Hz. Where required, a more detailed analysis can be conducted as per BS 6472–1992.
2 Values given for the most critical frequency range >8 Hz assuming sinusoidal motion. Where required, a more detailed analysis can be conducted as per AS 2670.2–1990. Sufficient justification should accompany the use of a peak velocity approach if used in an assessment.
3 Specific values depend on social and cultural factors, psychological attitudes and expected degree of intrusion.

Figure 4: Recommended Vibration Criteria (Impulsive Vibration, Daytime)

The German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in the table below.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 2 – DIN 4150-3 (1999-02) Safe Limits for Building Vibration

TYPE OF STRUCTURE		PEAK PARTICLE VELOCITY (mms^{-1})			
		At Foundation at a Frequency of			Plane of Floor of Uppermost Storey
		< 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used in commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

4 MEASURED NOISE LEVELS

The external noise monitoring data is presented in table 3 below and is graphed and attached in Appendix A of this report. Given the internal noise management level of 45dB(A)$_{Leq(15\text{-}min)}$ for hospital wards, this office has assumed the façade of the Brain Injury Unit would achieve minimum R_w30 and this has been used to determine the predicted internal noise level.

The measured average noise levels and frequencies during the construction monitoring period have been reviewed against the requirements of section 2.2 of this report and are presented and discussed below.

Table 3 – Measured Noise Levels

Noise Monitor Location	Date	Measured External Noise Level dB(A)$L_{eq(15\text{-}min)}$	Predicted Internal Noise Level dB(A)$L_{eq(15\text{-}min)}$	Internal Noise Management Level dB(A)$L_{eq(15\text{-}min)}$	Complies?
Liverpool Hospital, Brain Injury Unit (Garden Bed)	Friday, 26th February 2021	50-81	20-51	45	No
	Saturday, 27th February 2021	47-79	17-49		No
	Monday, 1st March 2021	46-81	16-51		No
	Tuesday, 2nd March 2021	50-75	20-45		Yes
	Wednesday, 3rd March 2021	51-73	21-43		Yes
	Thursday, 4th March 2021	47-74	17-44		Yes
	Friday, 5th March 2021	48-73	18-43		Yes
	Saturday, 6th March 2021	44-75	14-45		Yes
	Monday, 8th March 2021	52-76	22-46		Marginal
	Tuesday, 9th March 2021	52-71	22-41		Yes
	Wednesday, 10th March 2021	62-74	32-44		Yes
	Thursday, 11th March 2021	57-75	27-45		Yes
	Friday, 12th March 2021	56-74	26-44		Yes

5 MEASURED VIBRATION LEVELS

The vibration monitoring data is presented in table 4 below and has been graphed and attached in Appendix B of this report. The measured vibration levels and frequencies of each event have been reviewed against the requirements of section 3.2 of this report and are presented and discussed below.

*Note: This office has undertaken simultaneous attended internal and external vibration measurements during construction activities within the Multi-Storey Car Park construction site. The findings of the internal and external vibration measurements reveal that the internal vibration within the Brain Injury Unit is slightly attenuated in comparison to the external vibration monitoring location where the geophone is located along the Brain Injury Unit façade.

Table 4 – Measured Vibration Levels

Vibration Monitor Location	Date	Maximum Measured Vibration Level PPV (mm/s)	Time (24hr)	Target Vibration Limit* PPV (mm/s)	Complies?	DIN 4150 Building Damage Vibration Criteria* PPV (mm/s)	Complies?
Liverpool Hospital, Brain Injury Unit	Friday, 26th February 2021	0.32	15:50	<0.56	Yes	<20	Yes
	Saturday, 27th February 2021	1.19	11:30		No		Yes
	Monday, 1st March 2021	1.66	08:47		No		Yes
	Tuesday, 2nd March 2021	0.73	11:25		No		Yes
	Wednesday, 3rd March 2021	0.53	10:35		Yes		Yes
	Thursday, 4th March 2021	0.56	13:00		Yes		Yes
	Friday, 5th March 2021	1.50	14:25		No		Yes
	Saturday, 6th March 2021	0.93	07:51		No		Yes
	Monday, 8th March 2021	0.68	14:50		No		Yes
	Tuesday, 9th March 2021	0.41	07:25		Yes		Yes
	Wednesday, 10th March 2021	0.68	13:05		No		Yes
	Thursday, 11th March 2021	0.88	07:58		No		Yes
	Friday, 12th March 2021	0.50	07:45		Yes		Yes

*We note that the 0.56mm/s PPV is the vibration management level for humans' comfort and that 20mm/s PPV is the vibration criteria based on German Standard DIN 4150 for building damage. Given this, exceedances of the 0.56mm/s PPV would not result in damage to the building structure.

6 CONCLUSION

Acoustic Logic has been engaged to conduct a noise and vibration monitoring service during the Stage 1 construction phase of the Liverpool Hospital Multi-Storey Carpark.

This report includes noise and vibration monitoring results between the 26th February 2021 to the 12th March 2021.

During the monitoring period, it is noted that generally the noise and vibration generation from construction activities being undertaken at the Stage 1 Multi-Storey Car Park project site is above the recommended noise and vibration limits established in sections 2.2 and 3.2 of this report. However; as discussed above, exceedances of the humans' comfort vibration limit would not result in damage to the building structure as the vibration levels measured during the monitoring period are below the DIN-4150 vibration criteria.

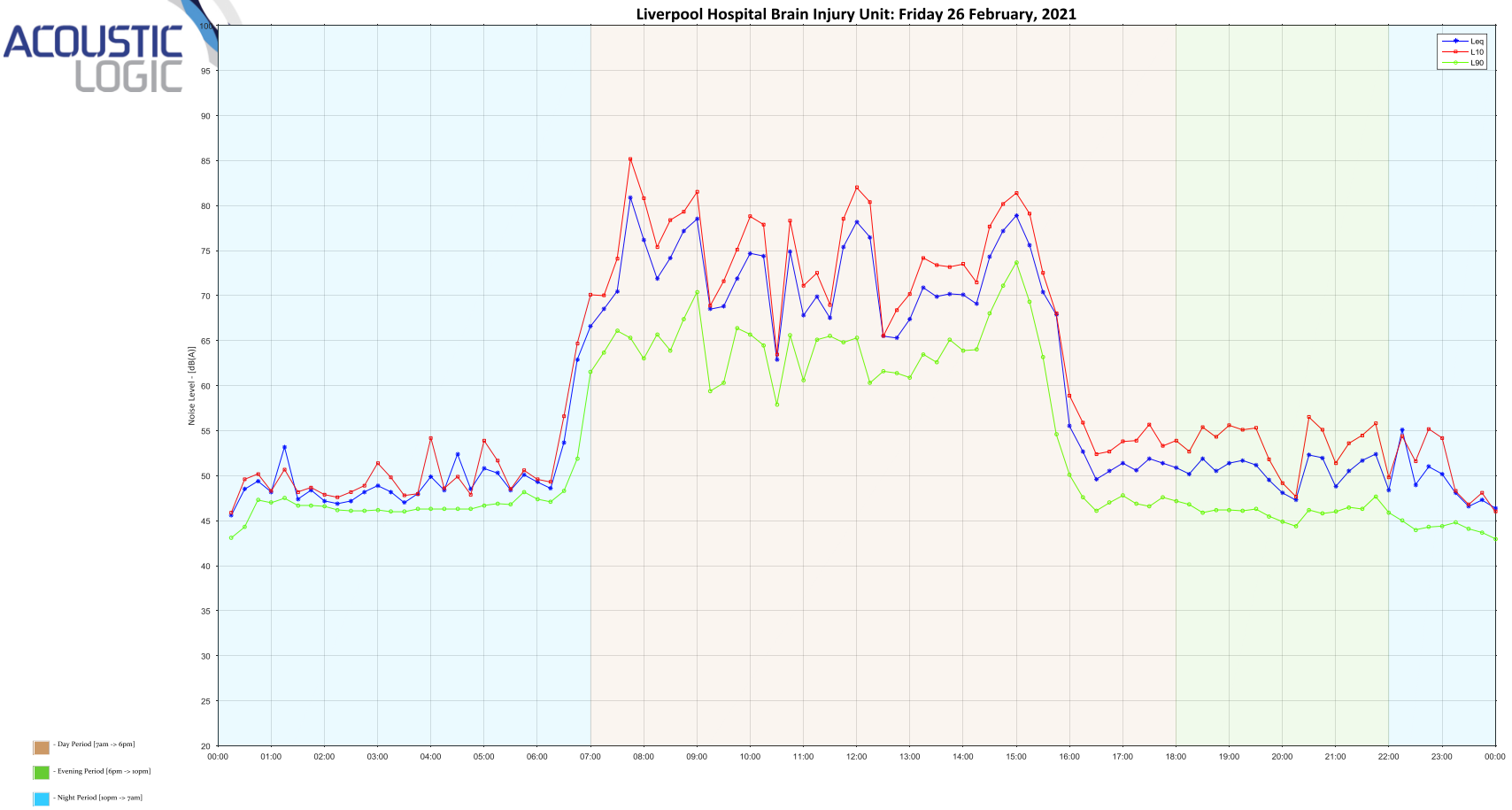
In addition, it is recommended to review the *'Ameliorative Measures'* detailed in the *'Stage 1 – Construction Noise and Vibration Management Plan'* (Ref: 20200931.1/0412A/R3/SN) dated 4/12/2020 prepared by this office for ongoing construction works to be undertaken at the project site.

We trust this information is satisfactory. Please contact us should you have any further queries.

Yours faithfully,

Acoustic Logic Pty Ltd
Shane Nichols

APPENDIX A – NOISE MONITORING DATA (LIVERPOOL HOSPITAL BRAIN INJURY UNIT)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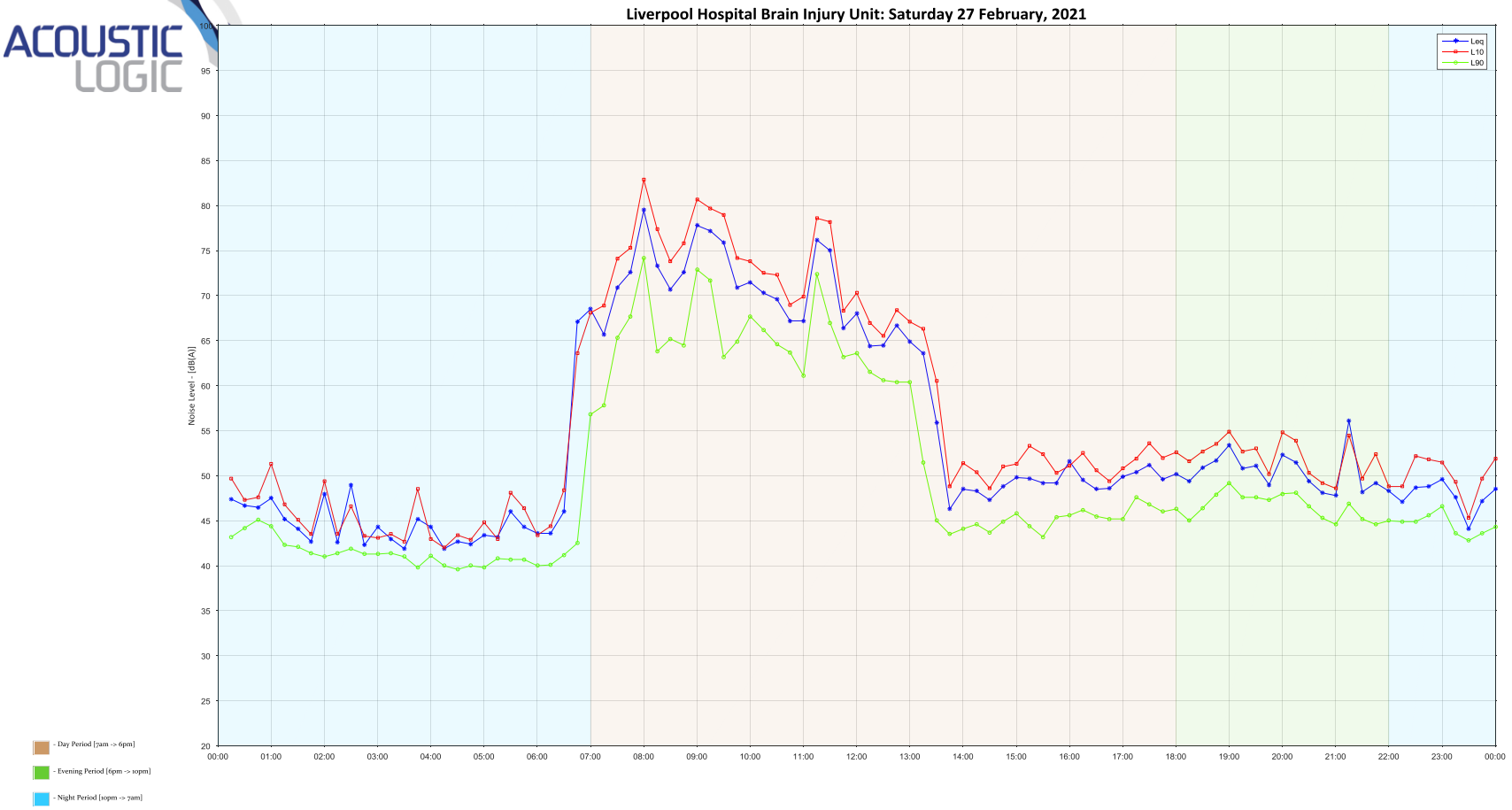
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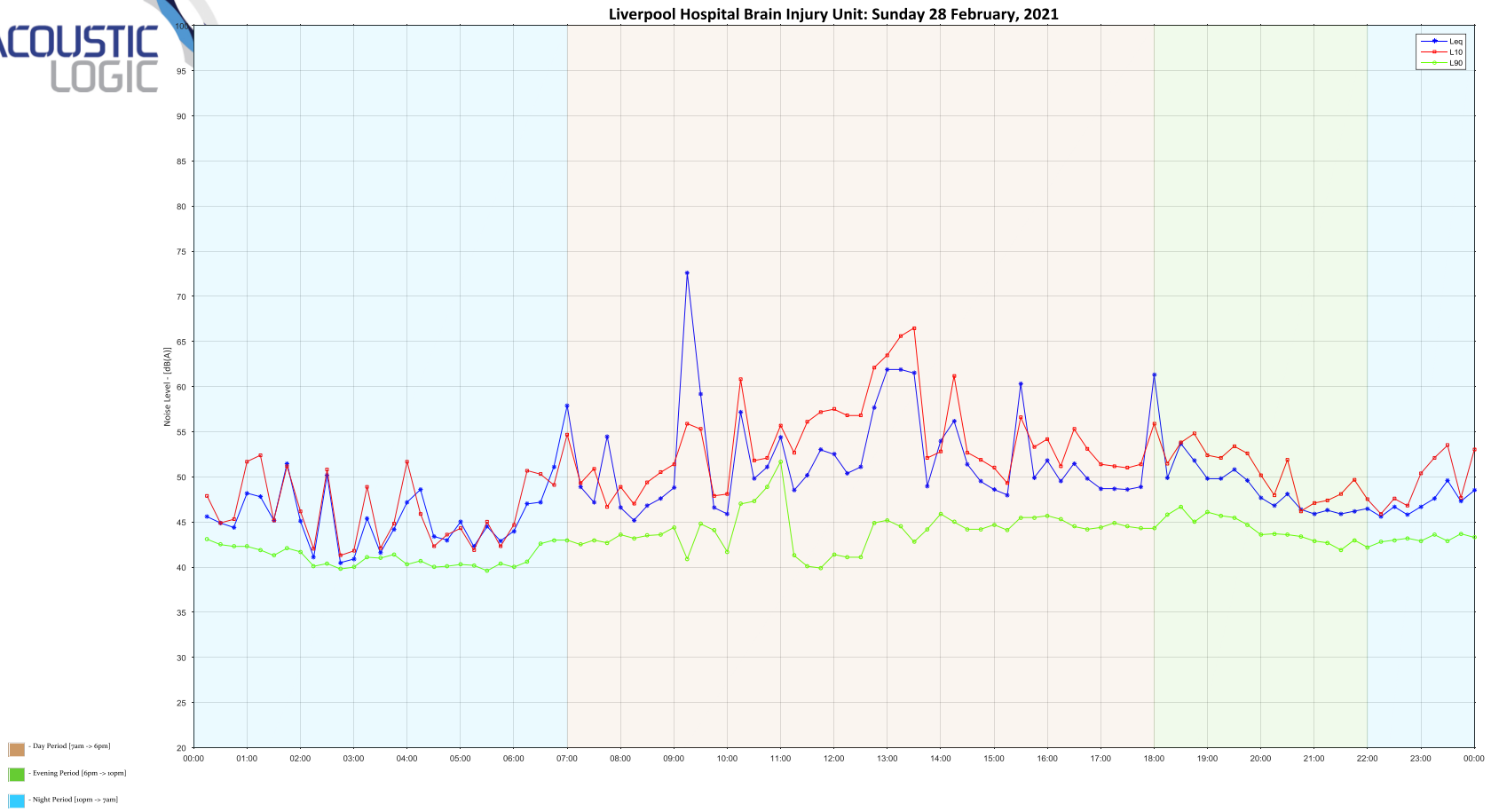
Liverpool Hospital Brain Injury Unit: Sunday 28 February, 2021
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Noise Level - [dB(A)]
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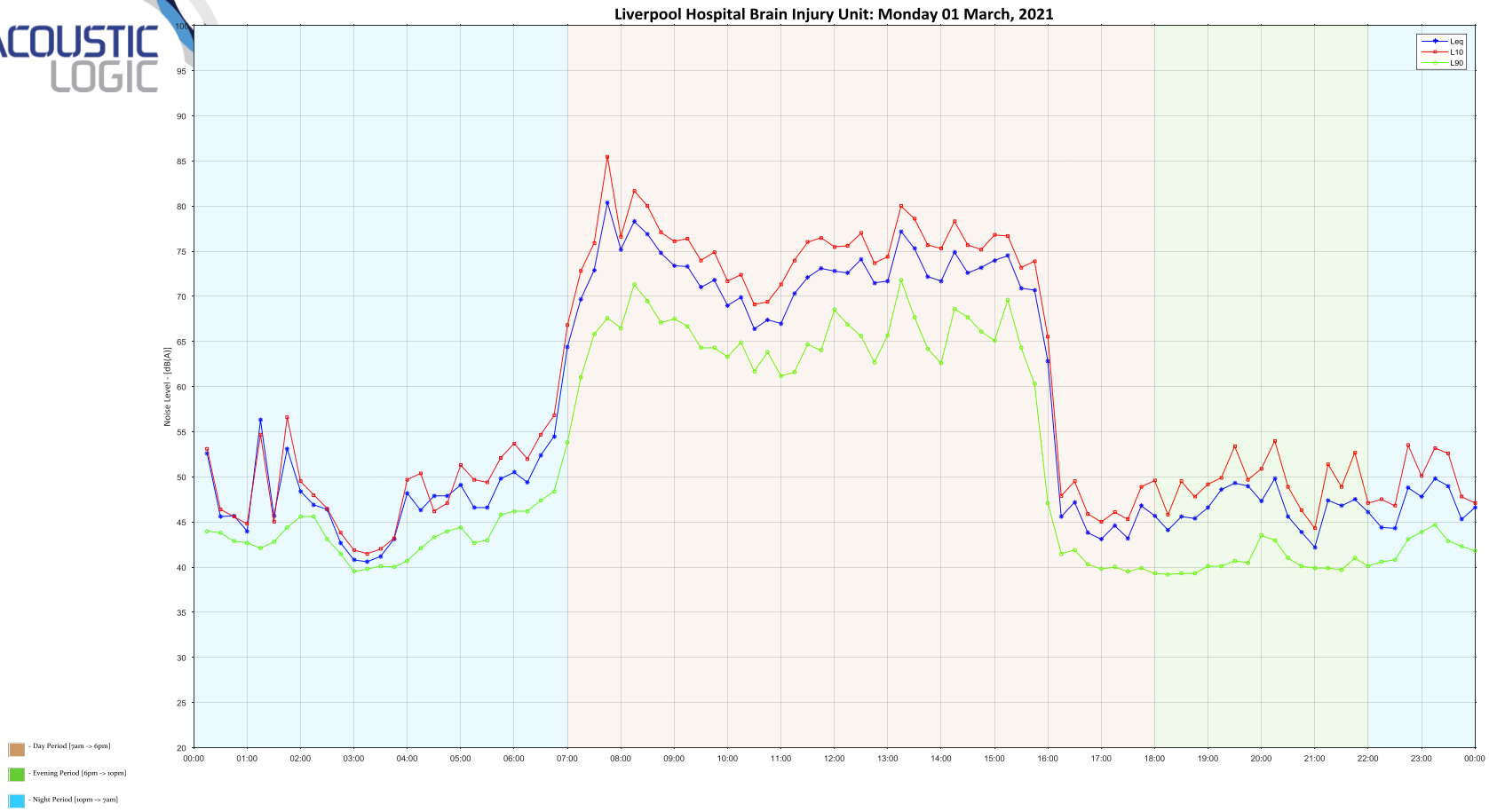
Liverpool Hospital Brain Injury Unit: Monday 01 March, 2021
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Noise Level - [dB(A)]
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- Evening Period [6pm -> 10pm]
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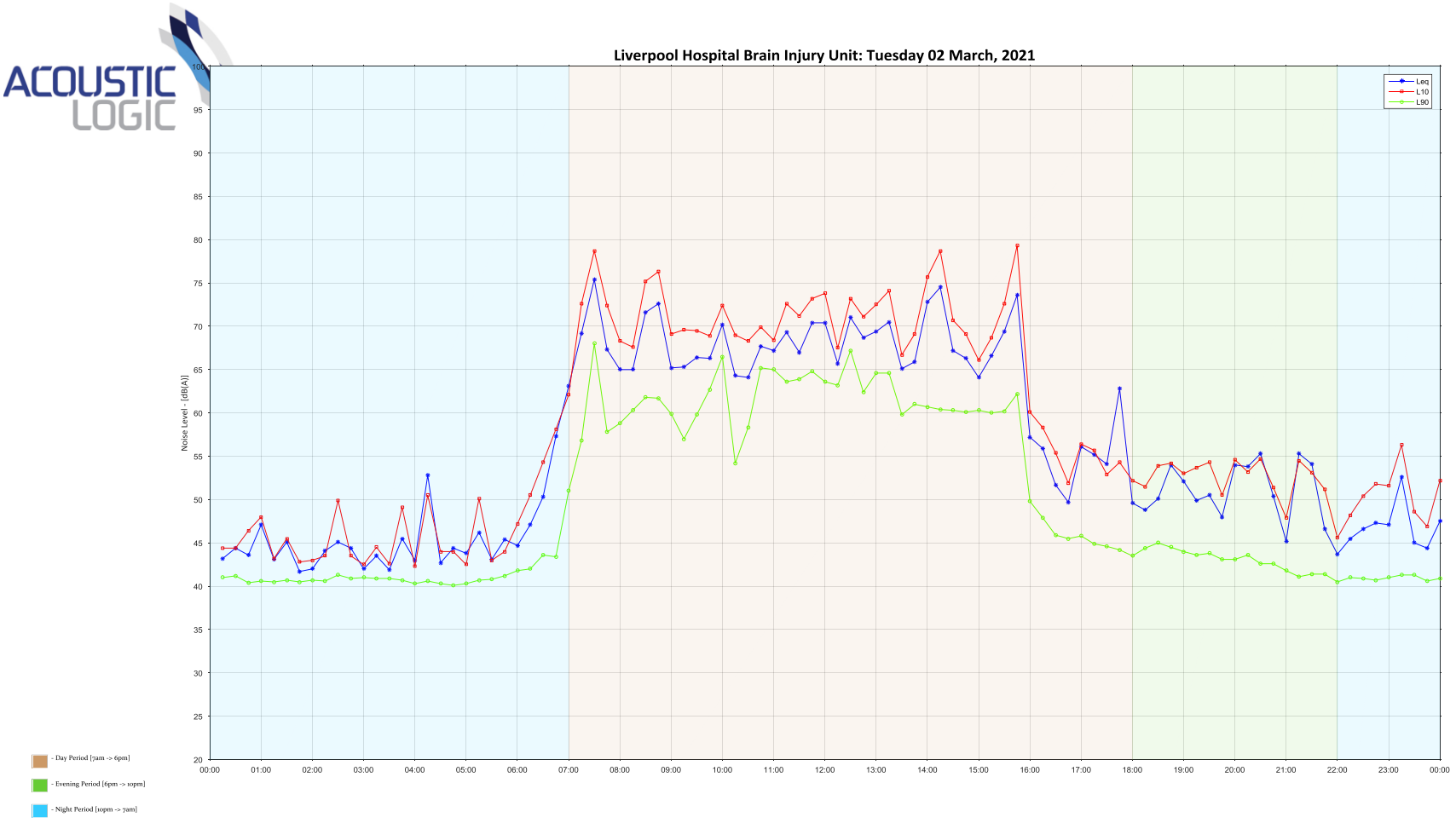
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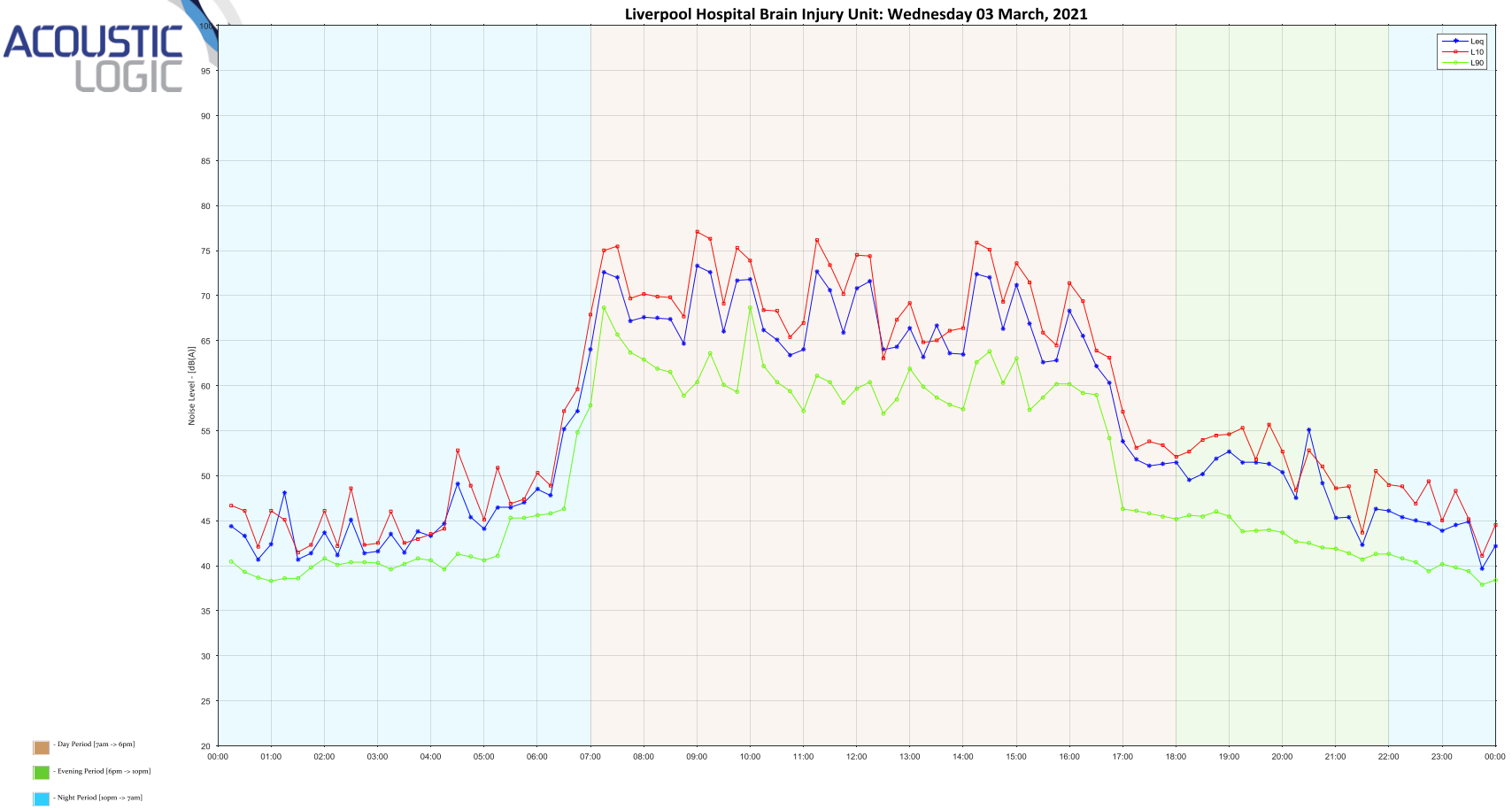
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Noise Level - [dB(A)]
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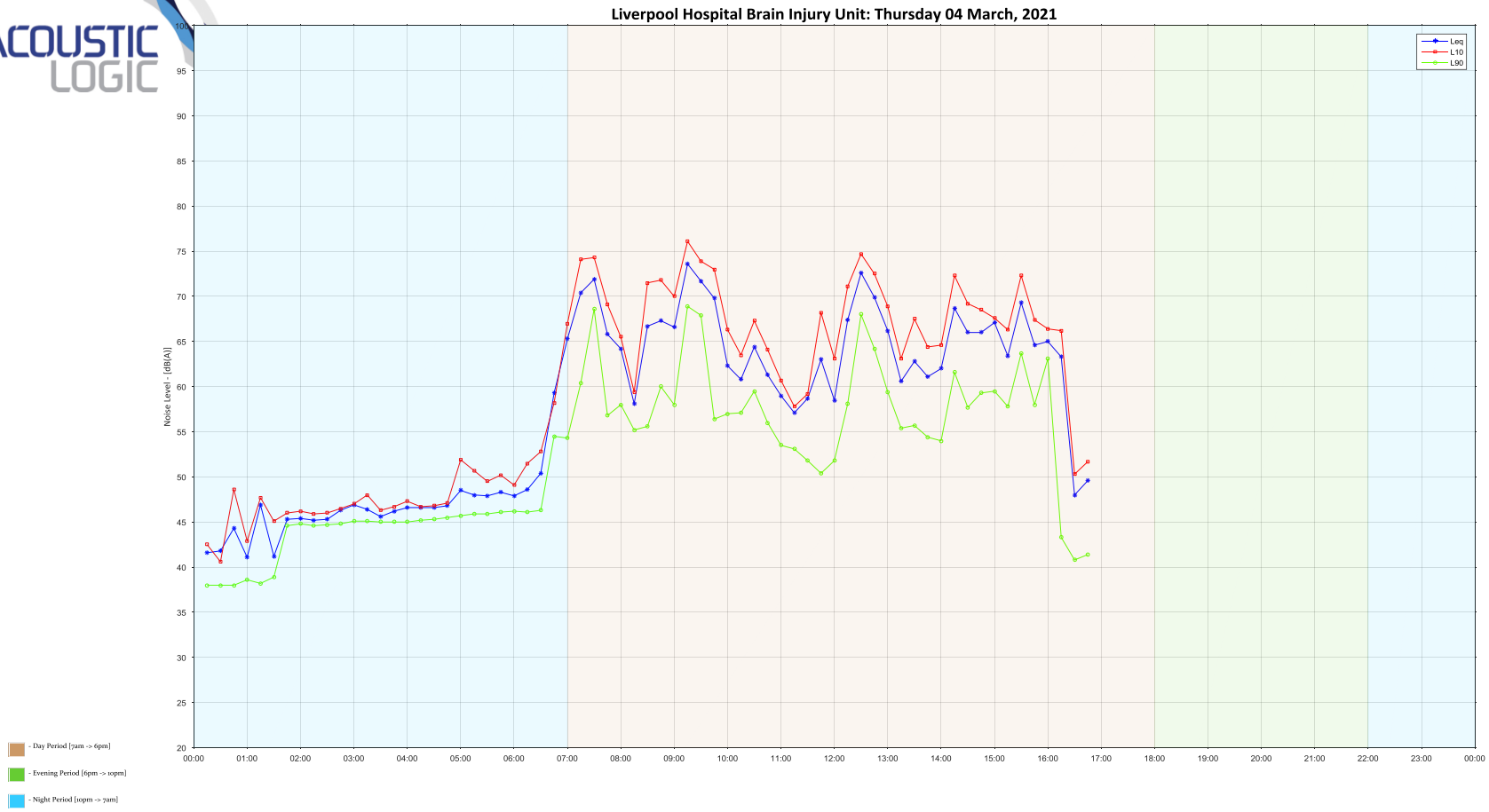
Liverpool Hospital Brain Injury Unit: Thursday 04 March, 2021
Noise Level - [dB(A)]
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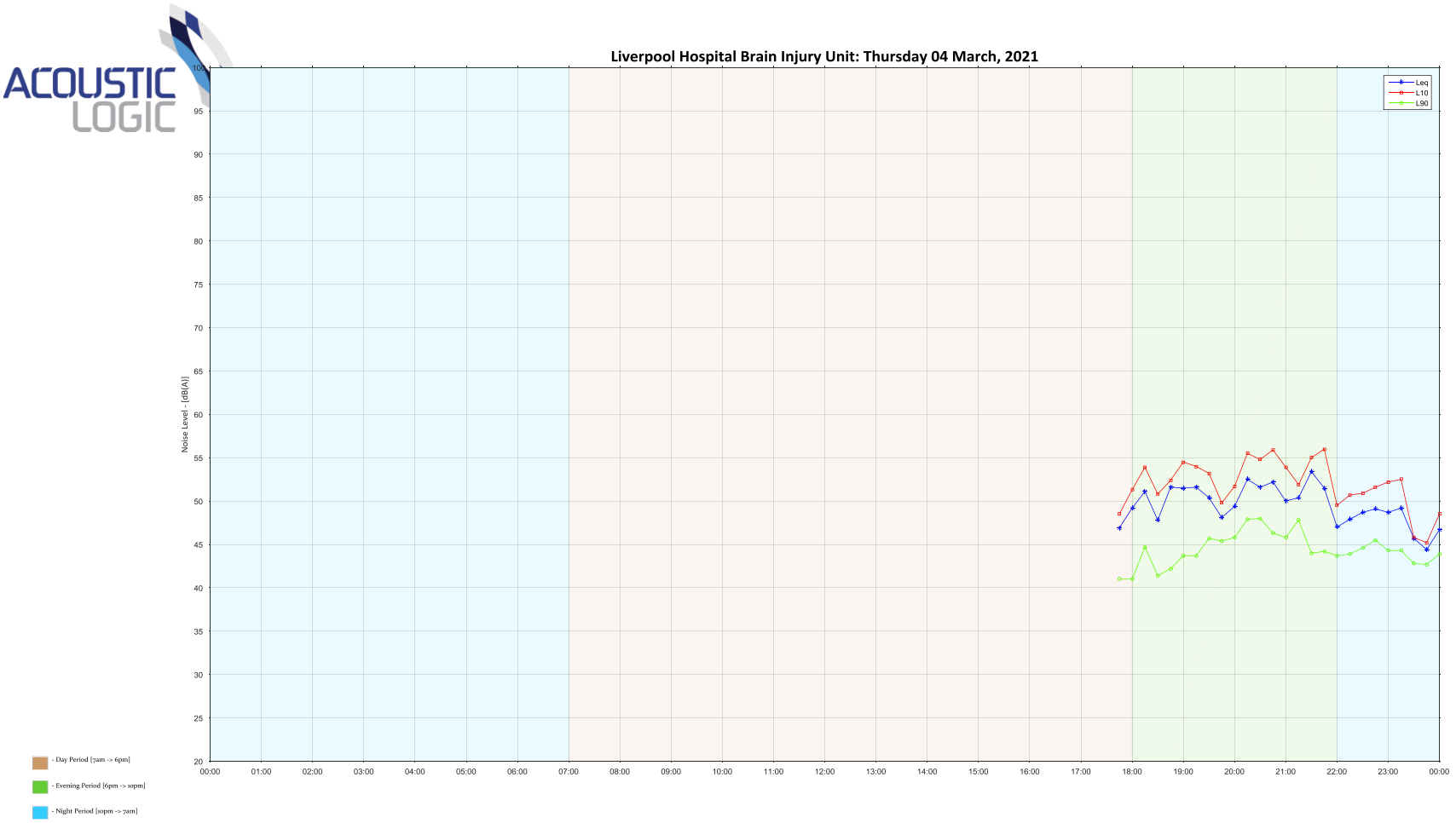
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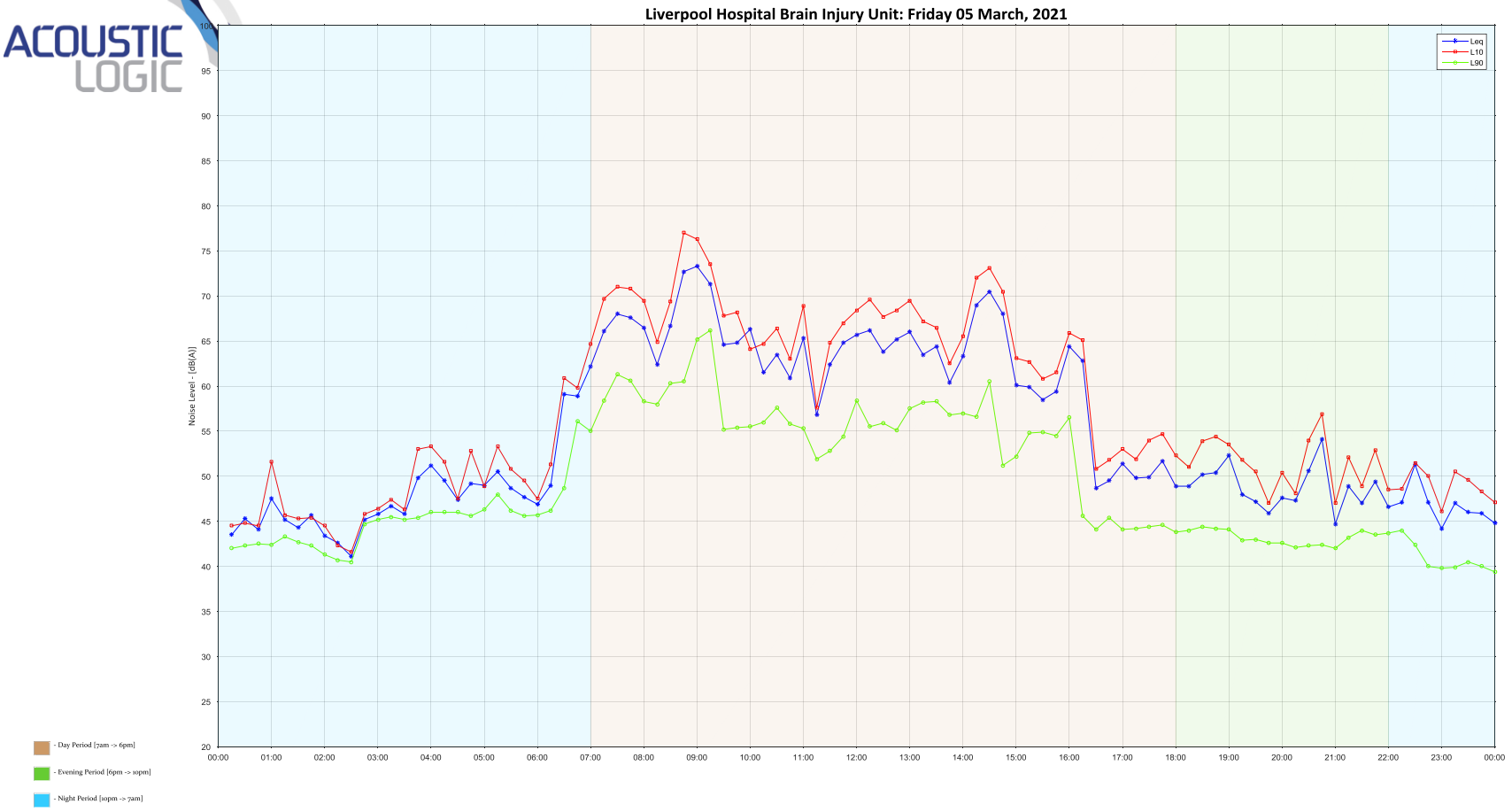
Liverpool Hospital Brain Injury Unit: Friday 05 March, 2021
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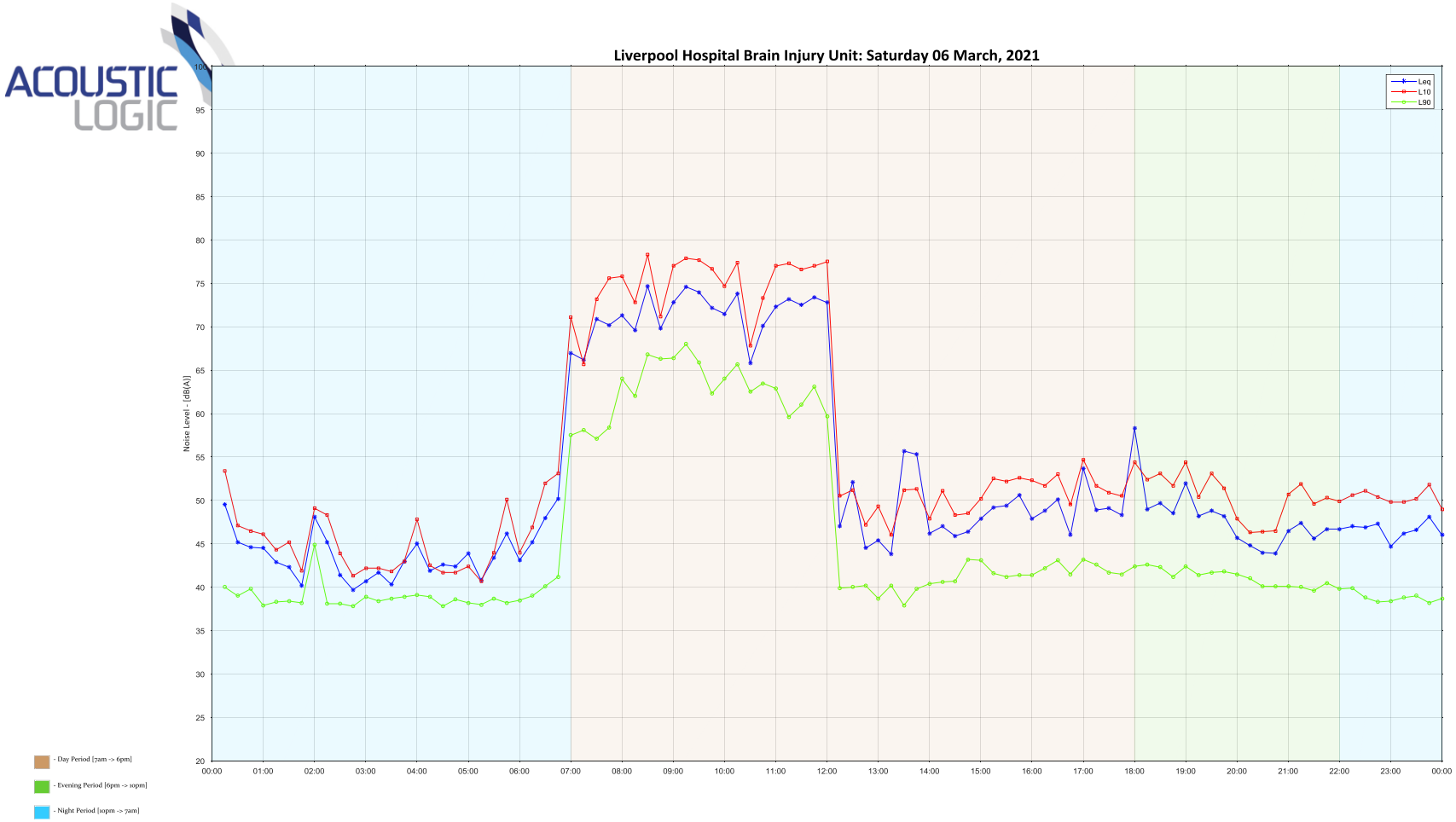
Liverpool Hospital Brain Injury Unit: Saturday 06 March, 2021
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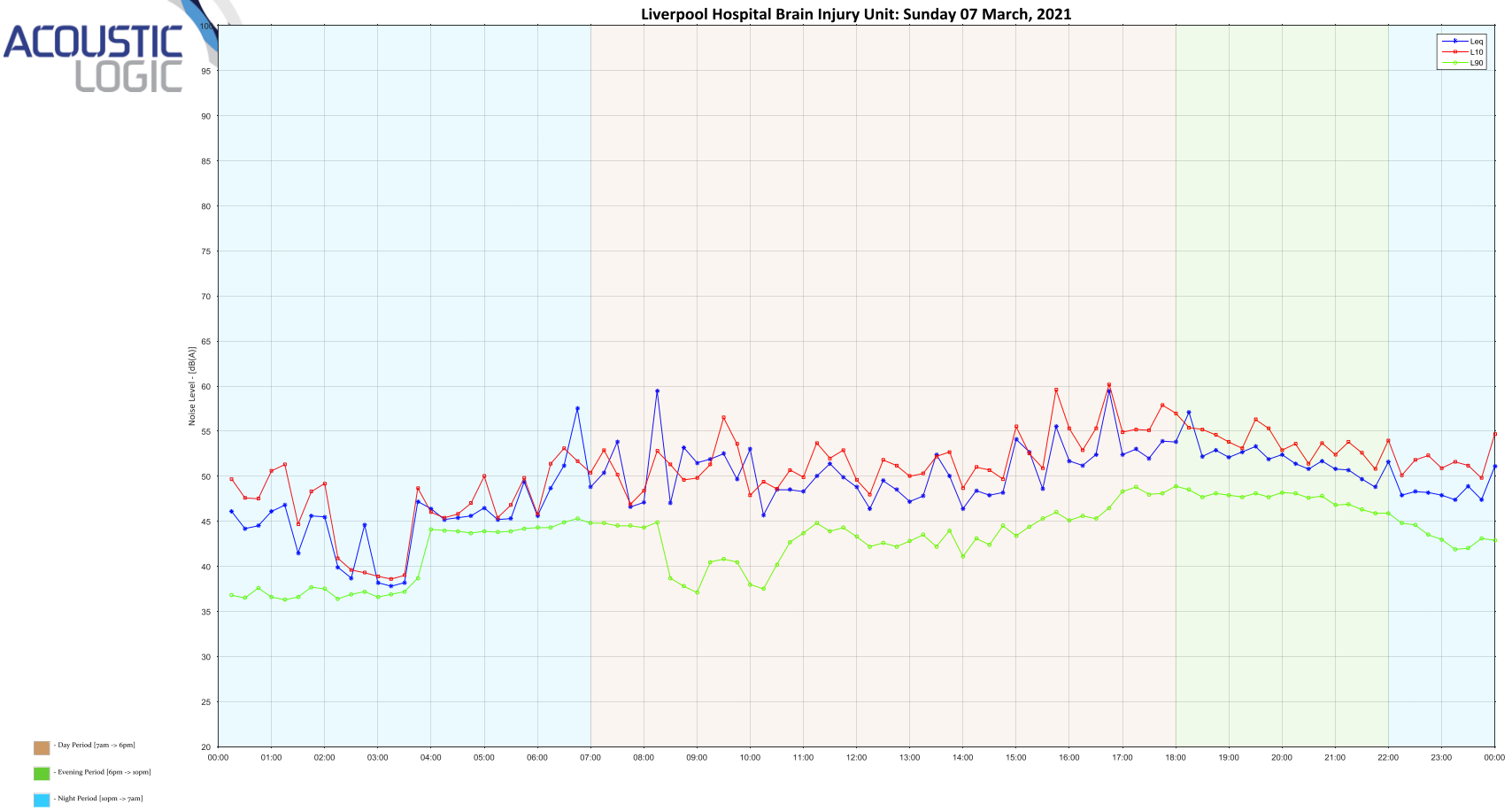
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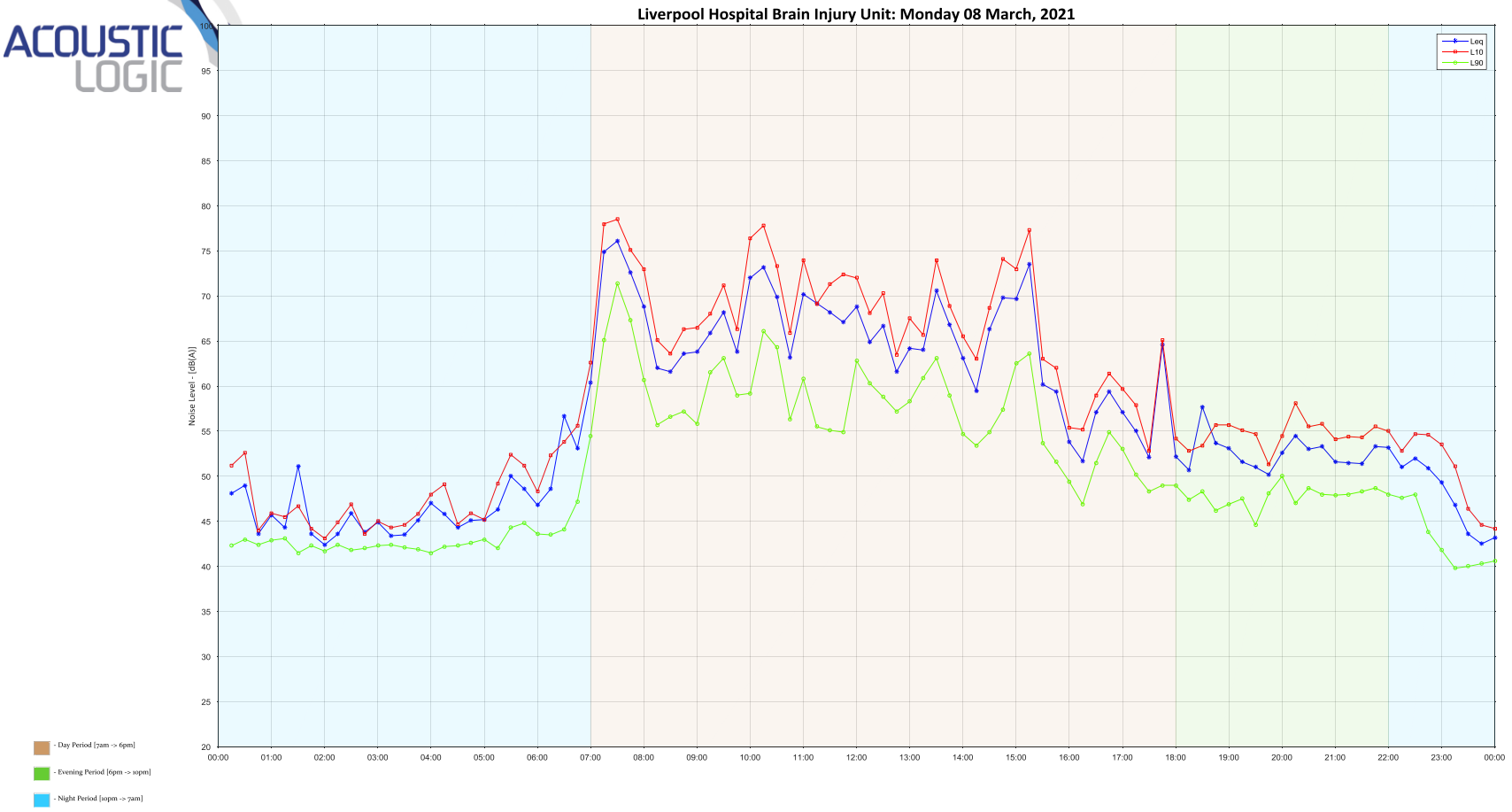
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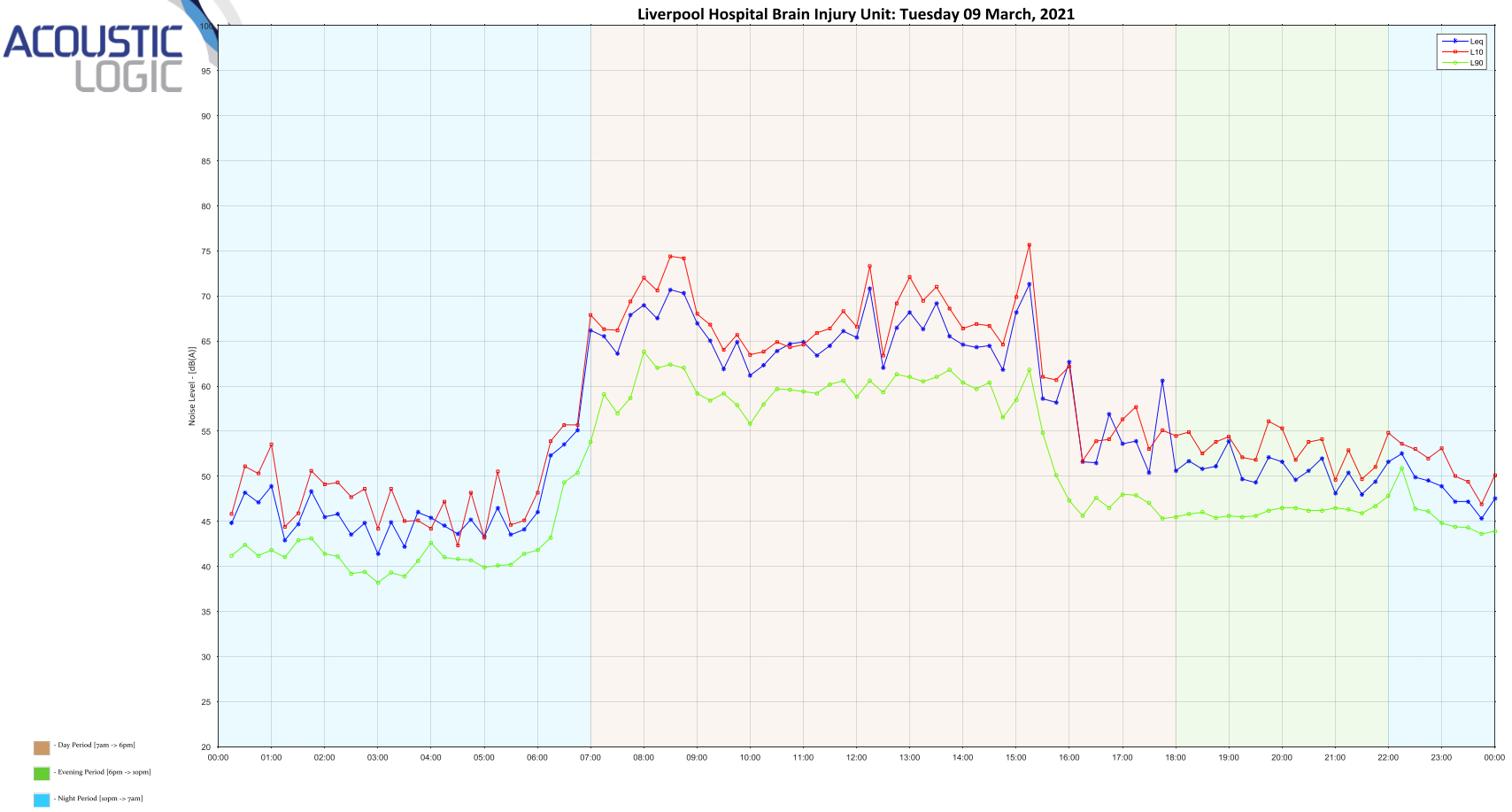
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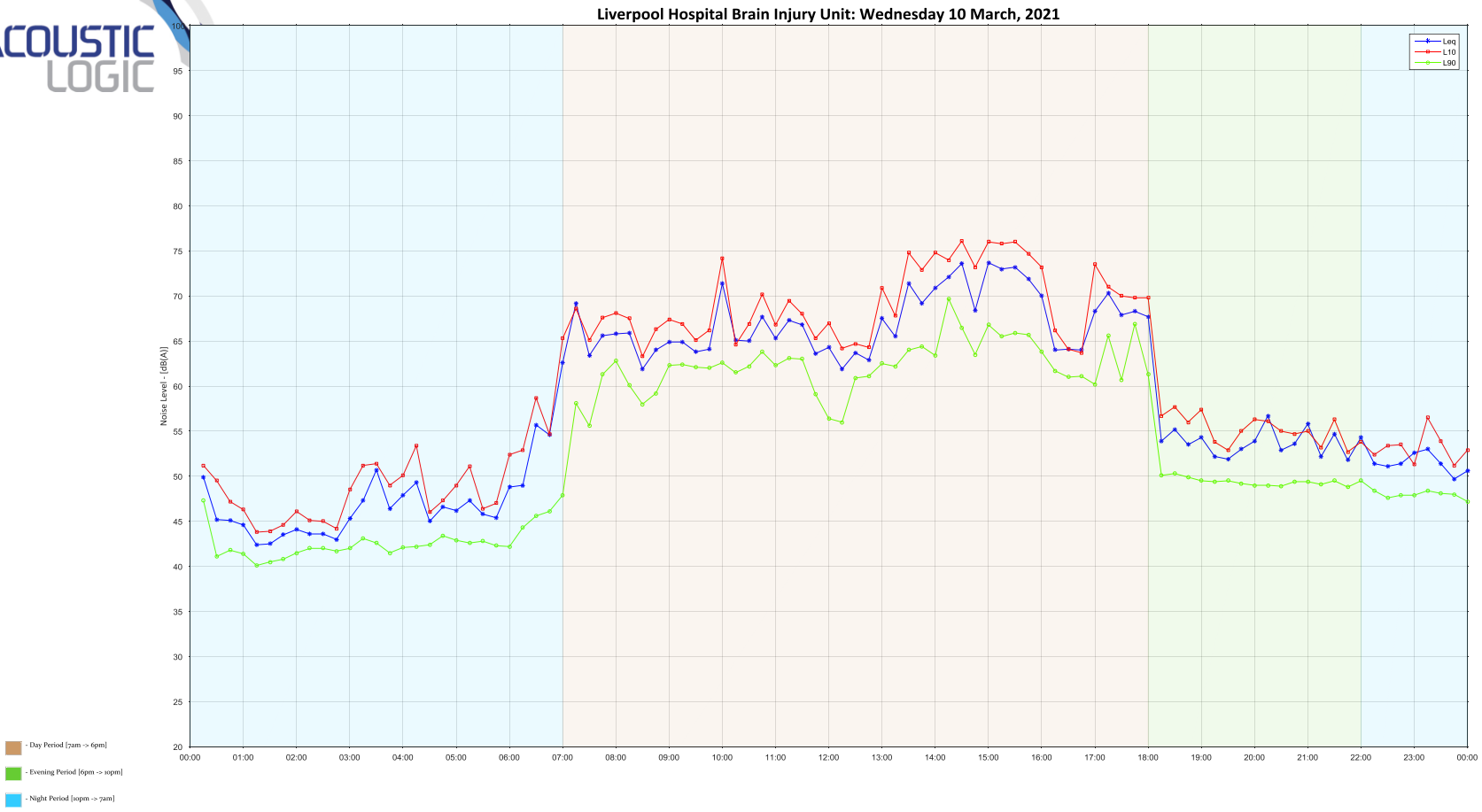
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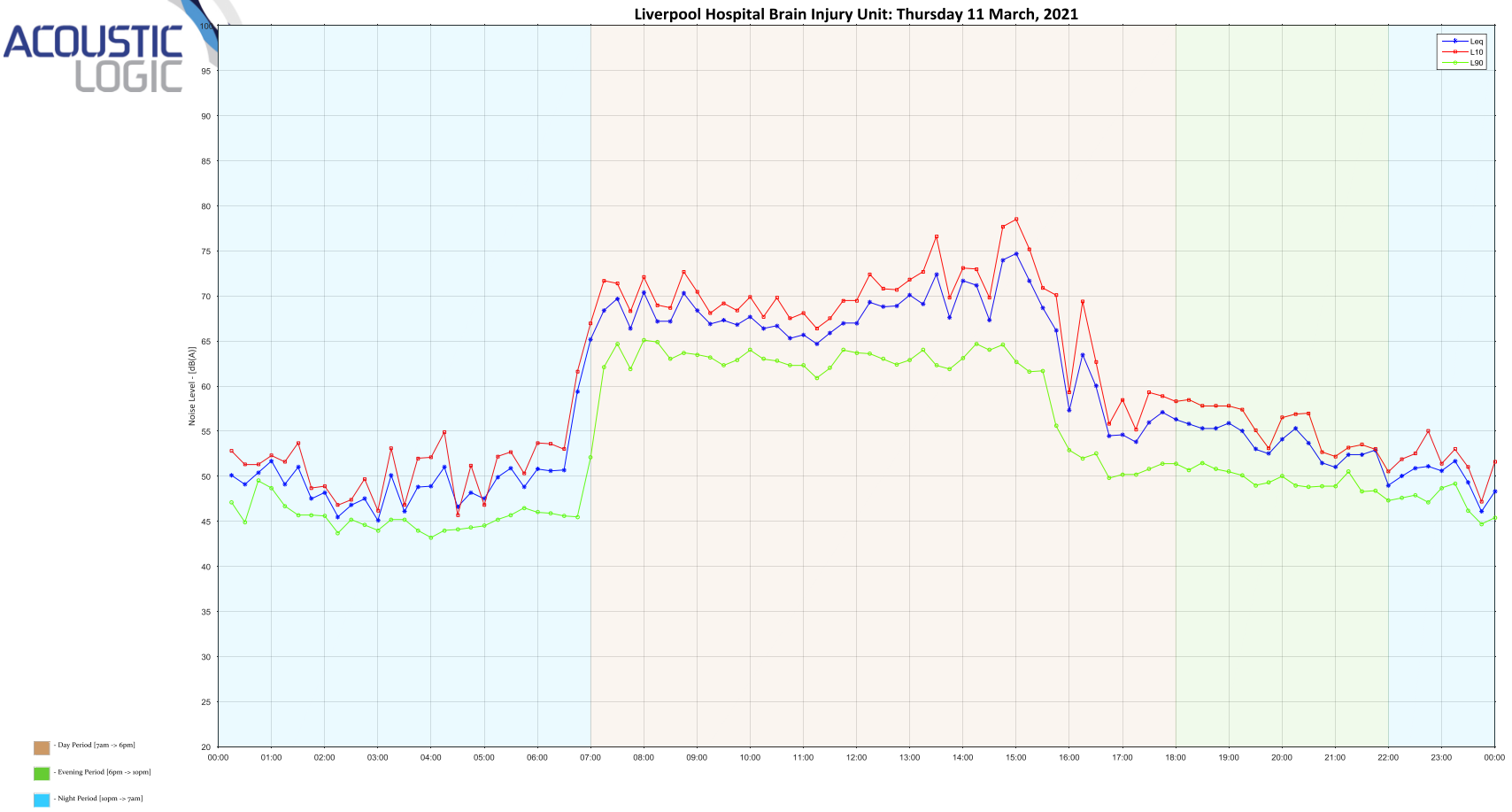
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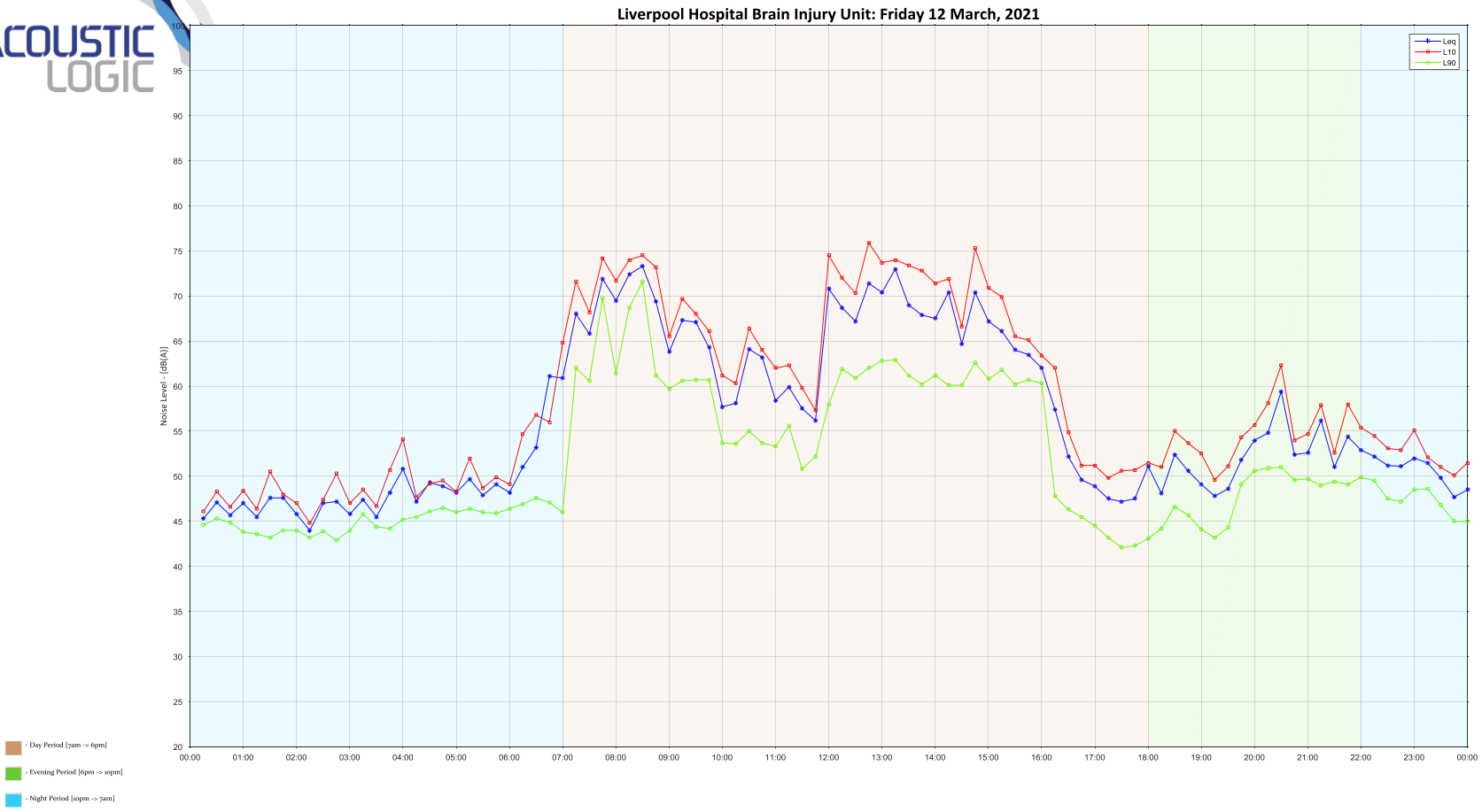
Liverpool Hospital Brain Injury Unit: Friday 12 March, 2021
Noise Level - [dB(A)]
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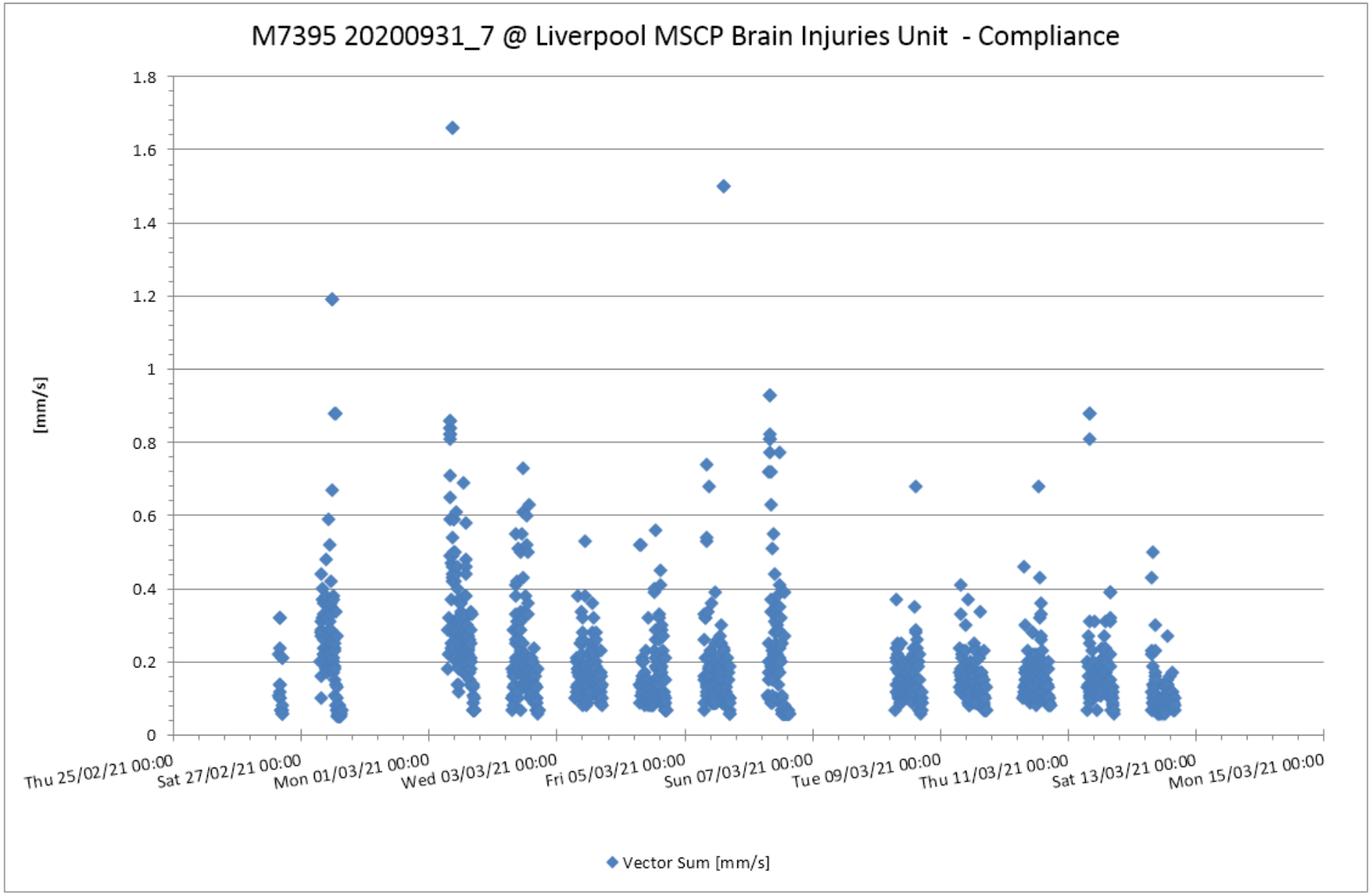
APPENDIX B – VIBRATION MONITORING DATA (LIVERPOOL HOSPITAL BRAIN INJURY UNIT)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Sat 27/02/21 00:00
Mon 01/03/21 00:00
Wed 03/03/21 00:00
Fri 05/03/21 00:00
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Sat 13/03/21 00:00
Mon 15/03/21 00:00
Vector Sum [mm/s]