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THE STAR - PIRRAMA ROAD EXTERNAL ENTERTAINMENT DECK

Amplified Music Acoustic Assessment

8 May 2014

Echo Entertainment (The Star)

TG004-13F04 (r2) L3 S75W DoP Report

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Document details

Detail	Reference
Doc reference:	TG004-13F04 (r2) L3 S75W DoP Report
Prepared for:	Echo Entertainment (The Star)
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Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Authorised
01/04/2014	Draft	0		AC	GW	
17/04/2014	Issued draft		1	AC	GW	GW
08/05/2014	For submission		2	GW		GW

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1 Introduction

Renzo Tonin & Associates was engaged to carry out a noise assessment relating to the provision of speakers and music on the Level 3 Pirrama Road External Entertainment Deck ('the Deck') at The Star, Pyrmont. This report has been prepared to assess the S75W application to be lodged with the Department of Planning and Environment that seeks to amend conditions within Major Project Approval MP08_0098 that currently prohibit speakers and music being provided on the Deck.

The use of the Deck is approved under Condition F7 for a patron capacity of 1000 between 7:00am and midnight and 600 between midnight and 7:00am. Noise emission from the use, irrespective of amplified music being provided is required to comply with the noise criteria set out in Condition F5. An assessment of speakers and music on the Deck has been carried out in accordance with the the requirements of Condition F5 noise criteria.

This report presents the results of the study undertaken by Renzo Tonin & Associates to establish project noise goals in accordance with the existing conditions as set out in Condition F5 and quantify noise emission from the provision of amplified music with patrons on the Deck, to the nearest most potentially affected receiver locations surrounding the site.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

2 Noise criteria

The standard noise criteria for music and activities at The Star are stipulated in Condition F5 of Major Project Approval MP08-0098 as follows:

> *Noise caused by the approved use including music and other activities must comply with the following criteria:*
>
> *The use must not result in the transmission of "offensive noise" as defined in the Protection of the Environment Operations Act 1997 to any place of different occupancy.*
>
> *The L10 noise level emitted from the use must not exceed 5dB above the background (L90) noise level in an Octave Band Centre Frequency (31.5Hz – 8kHz inclusive) between the hours 7:00am and 12:00 midnight when assessed at the boundary of the nearest affected property. The background noise level must be measured in the absence of noise emitted from the use.*
>
> *The L10 noise level emitted from the use must not exceed the background (L90) noise level in an Octave Band Centre Frequency (31.5Hz – 8kHz inclusive) between the hours 12:00 midnight and 7:00am when assessed at the boundary of the nearest affected property. The background noise level must be measured in the absence of noise emitted from the use.*
>
> *Notwithstanding compliance with the above, the noise from the use must not be audible within any habitable room in any residential property between the hours of 12:00 midnight and 7:00am.*
>
> *The L10 noise level emitted from the use must not exceed the background noise level (L90) in any Octave Band Centre Frequency (31.5Hz to 8kHz inclusive) by more than 3dB when assessed indoors at any affected commercial premises.*

It is noted that as the proposal only seeks provision of speakers and music up to midnight the criteria applicable between 12:00 midnight and 7:00am has not been assessed in this report.

3 Project noise goals

3.1 Assessment locations

The nearest potentially affected residential receivers are identified in Table 1 and indicated in Figure 1. The assessment locations are consistent with those identified in the acoustic assessment prepared for Major Project Application (MP08_0098) for Project Star [1].

Table 1: Assessment locations

Location ID	Address	Description
A1	Sydney Wharf 9, 56-56A Pirrama Road, Pyrmont	Four storey residential apartment building approximately 215m to the northeast of the Pirrama Road Level 3 Terrace. Assessment has been carried out to the upper level of the apartment building, which has been defined as Level 3.
A2	2 Jones Bay Road, Pyrmont	Ten storey residential apartment building approximately 110m to the northwest from the Pirrama Road Level 3 Terrace. The apartment building is acoustically shielded from the terrace by The Star Multi Use Entertainment Facility (MUEF). Assessment has been carried out to the upper level of the apartment building, which has been defined as Level 9.

Figure 1: Level 3 Entertainment deck and assessment locations

3.2 Existing acoustic environment

Criteria for the assessment of operational noise are derived from the existing noise environment of an area, excluding noise from the subject development.

Appendix B of the NSW EPA *Industrial Noise Policy* (INP, 2000) outlines two methods for determining the background noise level of an area, being 'B1 – Long-term background noise method' and 'B2 – Short-term background noise method'. This assessment has used long-term noise monitoring.

As the noise environment of an area almost always varies over time, background and ambient noise levels need to be determined for the operational times of the proposed development. For example, in a suburban or urban area the noise environment is typically at its minimum at 3am in the morning and at its maximum during the morning and afternoon traffic peak hours. The INP outlines the following standard time periods over which the background and ambient noise levels are to be determined:

- Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays
- Evening: 18:00-22:00 Monday to Sunday & Public Holidays
- Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

The INP also outlines methods for assessing 'shoulder periods' being shorter periods on either side of a standard period, where the standard period noise levels are not representative. A shoulder period has been established between 10pm and midnight, as the night time period is not directly applicable and operational criteria differs after midnight.

3.3 Noise measurement locations

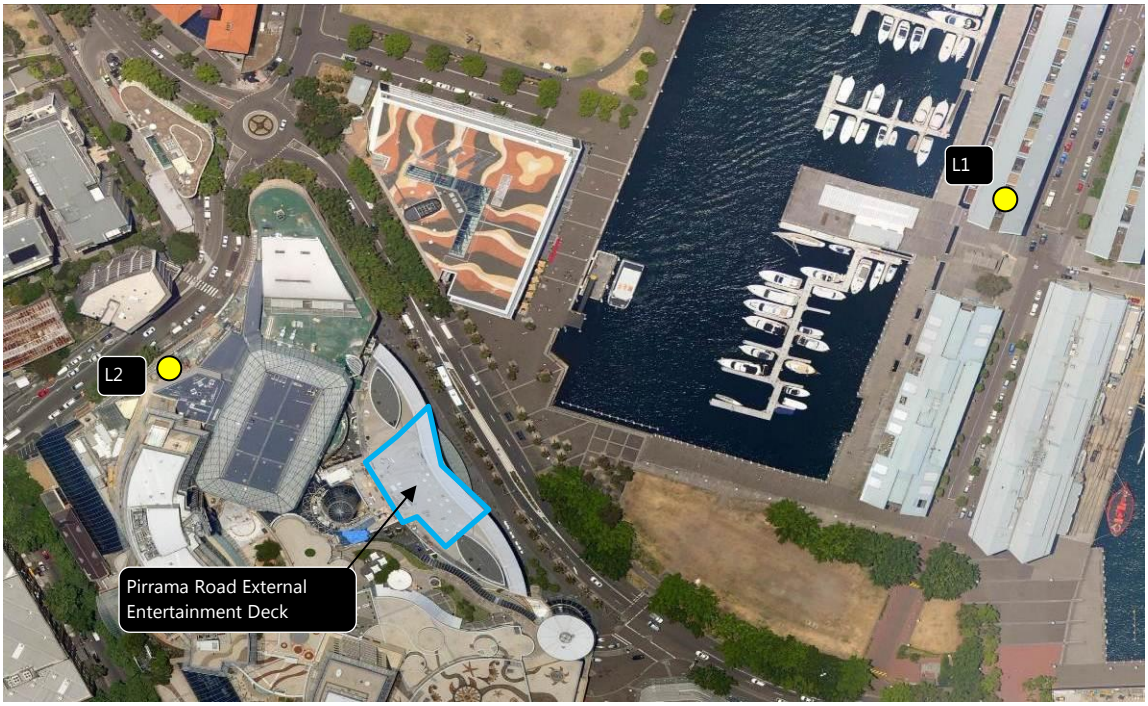
Noise measurements are ideally carried out at the nearest or most potentially affected locations surrounding a development. An alternative, representative location should be established in the case of access restrictions or a safe and secure location cannot be identified. Furthermore, representative locations may be established in the case of multiple receivers as it is usually impractical to carry out measurements at all locations surrounding a site.

The long-term measurement locations are outlined in Table 2 and shown in Figure 2.

Table 2: Noise monitoring locations

ID	Address	Description
Long-term noise monitoring		
L1	Unit 14, Wharf 9, Pyrmont	The monitor was located on the rooftop terrace in the free-field. The noise monitoring location is considered representative of receiver locations at Wharf 9. Measurements were undertaken between Monday, 3 February 2014 and Tuesday, 4 March 2014
L2	The Star, Level 5 Northern Terrace, Fronting Jones Bay Road	Noise monitor was positioned at the northern edge of the terrace area outside The Star Hotel rooms. Measurements were undertaken between Friday, 13 and Thursday, 26 August 2010

Figure 2: Site and noise monitoring locations



3.4 Long-term noise measurement results

The City of Sydney Council, as part of their review of recent development applications lodged for temporary use of amplified music, requested that background noise levels be monitored again in order to provide more current noise level data.

Accordingly, Renzo Tonin & Associates undertook monitoring of ambient and background noise levels at the most sensitive receptor, being Wharf 8/9. A location and accepted dates for monitoring was established through negotiation and consultation with the Chairman of Sydney Wharf Executive Committee. The long-term noise monitor was installed on Monday, 3 February 2014 and was originally to remain on site for a period of two weeks. However due to wind speeds exceeding the minimum 5m/s for a high proportion of the monitoring period, the survey was extended and concluded on Tuesday, 4 March 2014. Following completion of the noise monitoring, the Committee Chairman provided an overview of periods for which extraneous or erroneous noise events occurred. These periods were also reviewed in the analysis of the noise monitoring results and excluded where they affected the background noise level. Periods when the Deck was in operation were also excluded from the data.

Regarding the residential receptors along Jones Bay Road, the location is less sensitive to noise from the use of the Deck than Wharf 8/9. The additional mechanical plant equipment installed as part of Project Star in the vicinity of the residential premises may also contribute to the existing ambient noise levels, and therefore new noise monitoring would not represent the assessable background noise levels. The long-term noise monitoring carried out from Friday, 13 and Thursday, 26 August 2010 is therefore deemed appropriate for assessment.

Table 3 presents the overall Rating Background Levels (RBL) and octave band data, for each assessment period, determined in accordance with the INP. The long-term noise monitoring methodology is detailed in Appendix B, and noise level-vs-time graphs of the data are included in Appendix C.

Table 3: Long-term noise monitoring results

Descriptor	Period	Overall dB(A)	Octave band centre frequency – Hz (dBZ)								
			31.5	63	125	250	500	1k	2k	4k	8k
L1 - Sydney Wharf 9											
L_{90}	Day	53	59	58	55	53	50	48	42	32	18
	Evening	52	57	54	52	51	50	46	40	29	20
	22:00–00:00	50	56	54	52	50	46	44	38	28	18
	Night	47	55	52	50	48	44	41	35	27	17
L2 - Jones Bay Road											
L_{90}	Day	58	59	62	63	58	55	54	49	41	30
	Evening	59	58	60	62	61	57	54	48	40	30
	Night	54	58	58	60	54	51	50	45	37	25

Notes: Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays
Evening: 18:00-22:00 Monday to Sunday & Public Holidays
Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays
The shoulder period has been established for 22:00-00:00.
As required by the INP, the external ambient noise levels presented are free-field noise levels. [ie. no façade reflection]

The noise monitoring results reveal higher noise levels at the Jones Bay Road location. While the results may reflect the existing ambient noise level from localised traffic and activity in the area, the lower noise levels recorded at Location L1 have been used for the assessment.

3.5 Project noise goals

The background measurement results presented have been used to establish the noise goals for The Star in accordance with Condition F5.

Table 4: Project noise goals – Condition F5

Location	Time	Octave band centre frequency – Hz (dBZ)								
		31.5	63	125	250	500	1k	2k	4k	8k
A1 – Sydney Wharf 9	07:00 – 22:00^	62	59	57	56	55	51	45	34	25
	22:00 – 00:00	61	59	57	55	51	49	43	33	23
A2 – 2 Jones Bay Rd*	07:00 – 22:00^	62	59	57	56	55	51	45	34	25
	22:00 – 00:00	61	59	57	55	51	49	43	33	23

Notes: ^ Noise goals for the 07:00 to 22:00 period have been conservatively based on the lower evening background noise levels between 18:00-22:00.
* Noise goals established from noise monitoring at Location L1.

4 Noise assessment

4.1 Noise sources

Noise emission from events on the Deck will be determined by patron noise along with some background music. The noise source data used by for the predictive assessment, as set out in Table 5, is based on Renzo Tonin & Associates database of measurements of similar types of uses. The sound power level calculated per patron includes noise from background music. The data has been used for assessment at peak patron capacity of 1000 people.

With regard to the specific music noise levels, the required limits will ultimately vary dependent on the patron capacity during a specific use. As the cumulative impact is required to be assessed, the lowest music noise levels will be required during peak patron capacity. Lower patron capacities may permit higher music noise levels, while still complying with the overall noise emission criteria. Further discussion regarding the management of music noise levels is provided in Section 5.

For assessment of patron noise, it is noted that the City of Sydney typically expect reference data for voice levels to be used with an assumption that 50% of people are talking at the same time. Generally reference data for 'loud voices' would be used given the area and patron capacity of the Deck. Measurement results from compliance testing of a recent activity on the Deck confirm that the source noise data used by RT&A, as presented in Table 5 is more conservative than the 'standard reference data' approach and therefore appropriate.

Table 5: Source sound power levels

Item	Desc.	Overall dB(A)	Octave band centre frequency – Hz (dBZ)								
			31.5	63	125	250	500	1k	2k	4k	8k
L_w per person	L_{10}	85	79	79	78	77	82	81	77	70	56
L_w – 1000 patrons with music	L_{10}	115	109	109	108	107	112	111	107	100	86

4.2 Noise predictions

Noise predictions have been carried out using CadnaA noise modelling software implementing ISO9613 algorithms. The noise model assesses acoustic losses due to distance and shielding by intervening structures (eg the solid glazed balustrade along the Pirrama Road frontage), as well as reflections off surrounding buildings.

With regard to the balustrade, while the height of the barrier limits its effectiveness for patrons located immediately adjacent the balustrade, acoustic shielding is provided for a large majority of the deck area due to the lower height of Wharf 8/9 apartments.

The modelling results presented in Table 6 demonstrate compliance with the established Condition F5 noise goals. It is noted that there are no other areas of The Star that would contribute to a cumulative noise impact at location A1. With regard to location A2, other areas of The Star are in closer proximity to

and therefore may contribute higher noise levels. The predicted levels from the Deck use at location A2 are sufficiently below the total noise criteria so as not to contribute to any cumulative impact.

Table 6: Noise prediction summary

Description		Octave band centre frequency – Hz (dBZ)								
		31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Location A1 – Sydney Wharf 9										
Predicted noise level - 1000 people with music		47	47	46	45	50	48	43	33	7
07:00 - 22:00	*Criteria*	*62*	*59*	*57*	*56*	*55*	*51*	*45*	*34*	*25*
22:00 - 00:00	*Criteria*	*61*	*59*	*57*	*55*	*51*	*49*	*43*	*33*	*23*
Location A2 – 2 Jones Bay Road										
Predicted noise level - 1000 people with music		49	46	41	37	38	35	29	20	0
07:00 - 22:00	*Criteria*	*62*	*59*	*57*	*56*	*55*	*51*	*45*	*34*	*25*
22:00 - 00:00	*Criteria*	*61*	*59*	*57*	*55*	*51*	*49*	*43*	*33*	*23*

5 Noise management measures

The primary component for noise management is in regard to the music noise levels. While previously approved temporary uses have relied upon a portable sound system of 6-8 speakers, it is expected that if the modification is approved that permanent system would be installed. The installation of a permanent sound system would allow a more comprehensive noise monitoring and limiting system to be established and noise output verified.

Where a permanent system is installed, the music noise limits can be determined through compliance surveys following installation. It is proposed to control the music noise limits using a sound-pressure measurement/limiter device (eg CESVA LRF-04 and LRF-05 or APEX Argos and HERA) so that music noise levels will be controlled dependent on the overall noise generated by patrons and music combined.

Where an alternative sound system is proposed, it is recommended that the noise level be controlled by an electronic frequency dependant RMS limiting device (eg. a Rane HAL, BSS Blu-16, Symetrix Jupiter 8 or MediaMatrix X-Frame 88). For this case, indicative recommendations are provided regarding allowable sound pressure levels from each speaker, relative to the number of speakers installed. The more speakers installed, the lower the sound pressure permitted for each speaker. While the noise level in proximity to each speaker is reduced for a larger number of speakers, a greater distribution of music noise over the Deck can be provided. It is recommended that the noise limits be confirmed during post-operation compliance testing.

Table 7: Recommended sound system speaker noise levels, Lp @ 2m from each speaker

No. of Speakers	Descriptor	Octave Band Centre Frequency – Hz (dBZ)								
		31.5	63	125	250	500	1k	2k	4k	8k
2	L_{10}	107	104	102	98	94	91	87	77	77
4	L_{10}	104	101	99	95	91	88	84	74	74
8	L_{10}	101	98	96	92	88	85	81	71	71

6 Conclusion

Renzo Tonin & Associates has completed an assessment of noise emission from the use of speakers and music on The Star Pirrama Road External Entertainment Deck (the Deck), between the 7:00am and 12 midnight, which supports the S75W application to modify condition F1 of MP08-0098 that currently prohibits music being provided in the area.

Noise emission from the use of speakers and music on the Deck has been assessed against the existing conditions set out in Condition F5. The assessment determined that the provision of speakers and music between 7:00am and 12 midnight, with the maximum approved patron capacity of 1000 on The Deck can comply with the current noise conditions. Notwithstanding, the management of noise emission from the Deck will require installation of a noise monitoring/limiting device on any sound systems used on the Deck. Use of speakers and music between 12 midnight and 7:00m is not proposed.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L_{90} noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.

L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain L_{eq} sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Long-term noise monitoring methodology

B.1 Noise monitoring equipment

A long-term unattended noise monitor consists of a sound level meter housed inside a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period.

Long term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave band data	Logger location(s)
RTA06 (NTi Audio XL2, with low noise microphone)	Type 1	1/1 & 1/3	L1

Notes: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated either Type 1 or Type 2 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4230 or 4231 calibrator. No significant drift in calibration was observed.

B.2 Meteorology during monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NSW INP. Determination of extraneous meteorological conditions was based on data provided by the Bureau of Meteorology (BOM), for a location considered representative of the noise monitoring location(s). However, the data was adjusted to account for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10m above ground level, and the microphone location, which is typically 1.5m above ground level (and less than 3m). The correction factor applied to the data is based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

B.3 Noise vs time graphs

Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the L_{10}, L_{90}, and L_{eq} levels. The statistical descriptors L_{10} and L_{90} measure the noise level exceeded for 10% and 90% of the sample measurement time. The L_{eq} level is the equivalent continuous noise level or the level averaged on an equal energy basis. Measurement sample periods are usually ten to fifteen minutes. The Noise -vs- Time graphs representing measured noise levels, as presented in this report, illustrate these concepts for the broadband dB(A) results.

APPENDIX C Long-term monitoring results

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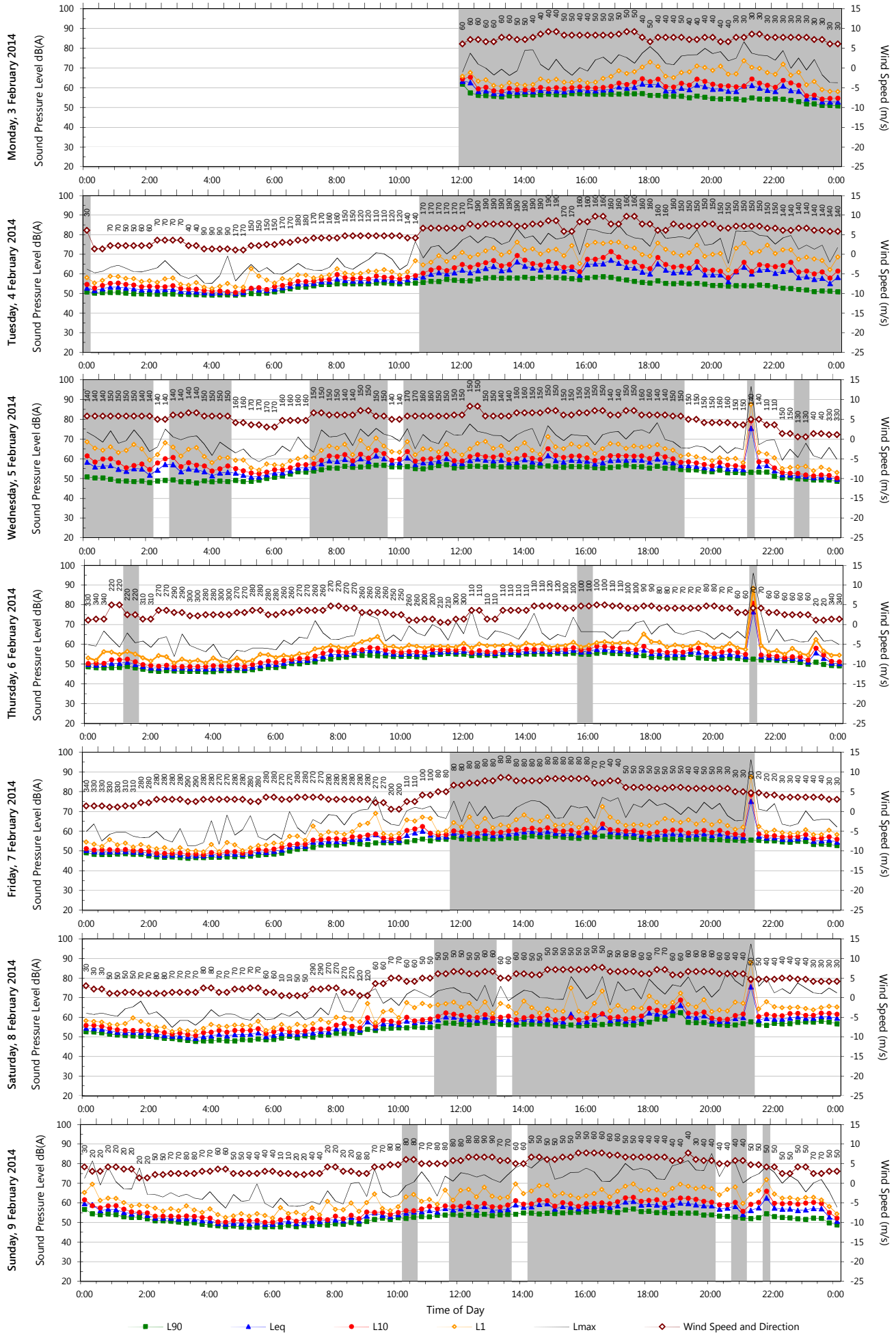
L1 - Rooftop Terrace of Unit 14, Wharf 9, Pyrmont

Background & Ambient Noise Monitoring Results - NSW 'Industrial Noise Policy', 2000						
	L_{A90} Background Noise Levels[5]			L_{Aeq} Ambient Noise Levels		
Date	**Day**	**Evening**	**Night**	**Day**	**Evening**	**Night**
Monday-03-February-2014	-	-	-	-	-	-
Tuesday-04-February-2014	-	-	-	-	-	-
Wednesday-05-February-2014	-	-	46	-	-	50
Thursday-06-February-2014	53	52	47	56	55	50
Friday-07-February-2014	-	-	48	-	-	53
Saturday-08-February-2014	-	-	48	-	-	55
Sunday-09-February-2014	-	-	-	-	-	-
Monday-10-February-2014	-	-	47	-	-	52
Tuesday-11-February-2014	54	-	50	56	-	52
Wednesday-12-February-2014	-	-	-	-	-	-
Thursday-13-February-2014	-	-	48	-	-	51
Friday-14-February-2014	53	54	-	57	57	-
Saturday-15-February-2014	-	-	-	-	-	-
Sunday-16-February-2014	-	-	-	-	-	-
Monday-17-February-2014	-	52	50	-	55	51
Tuesday-18-February-2014	55	52	46	58	55	50
Wednesday-19-February-2014	-	-	47	-	-	51
Thursday-20-February-2014	53	53	-	57	55	-
Friday-21-February-2014	-	-	48	-	-	53
Saturday-22-February-2014	-	-	49	-	-	56
Sunday-23-February-2014	-	-	47	-	-	50
Monday-24-February-2014	-	-	47	-	-	50
Tuesday-25-February-2014	-	-	-	-	-	-
Wednesday-26-February-2014	53	-	-	57	-	-
Thursday-27-February-2014	-	-	-	-	-	-
Friday-28-February-2014	-	54	-	-	56	-
Saturday-01-March-2014	-	-	-	-	-	-
Sunday-02-March-2014	-	51	48	-	54	52
Monday-03-March-2014	53	52	47	58	54	50
Tuesday-04-March-2014	54	-	-	57	-	-
Representative Week	**54**	**52**	**48**	**57**	**55**	**52**

Notes:

1. Day is taken to be 7:00am to 6:00pm
2. Evening is taken to be 6:00pm to 10:00pm.
3. Night is taken to be the remaining periods.
4. Rating Background Level (RBL) for L90 and logarithmic average for Leq
5. Assessment Background Level (ABL)
6. Rating Background Level (RBL) for L90 and logarithmic average for Leq



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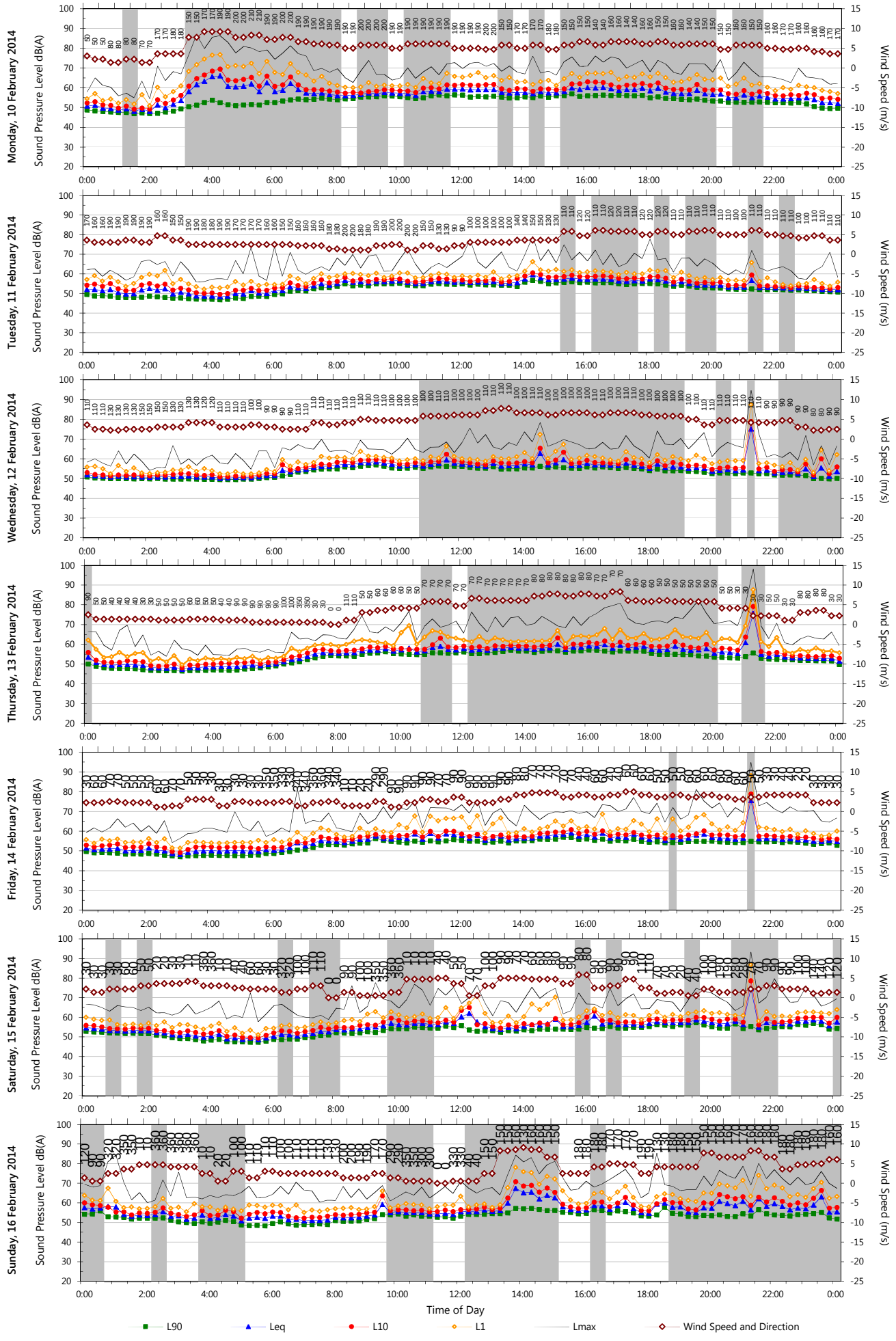

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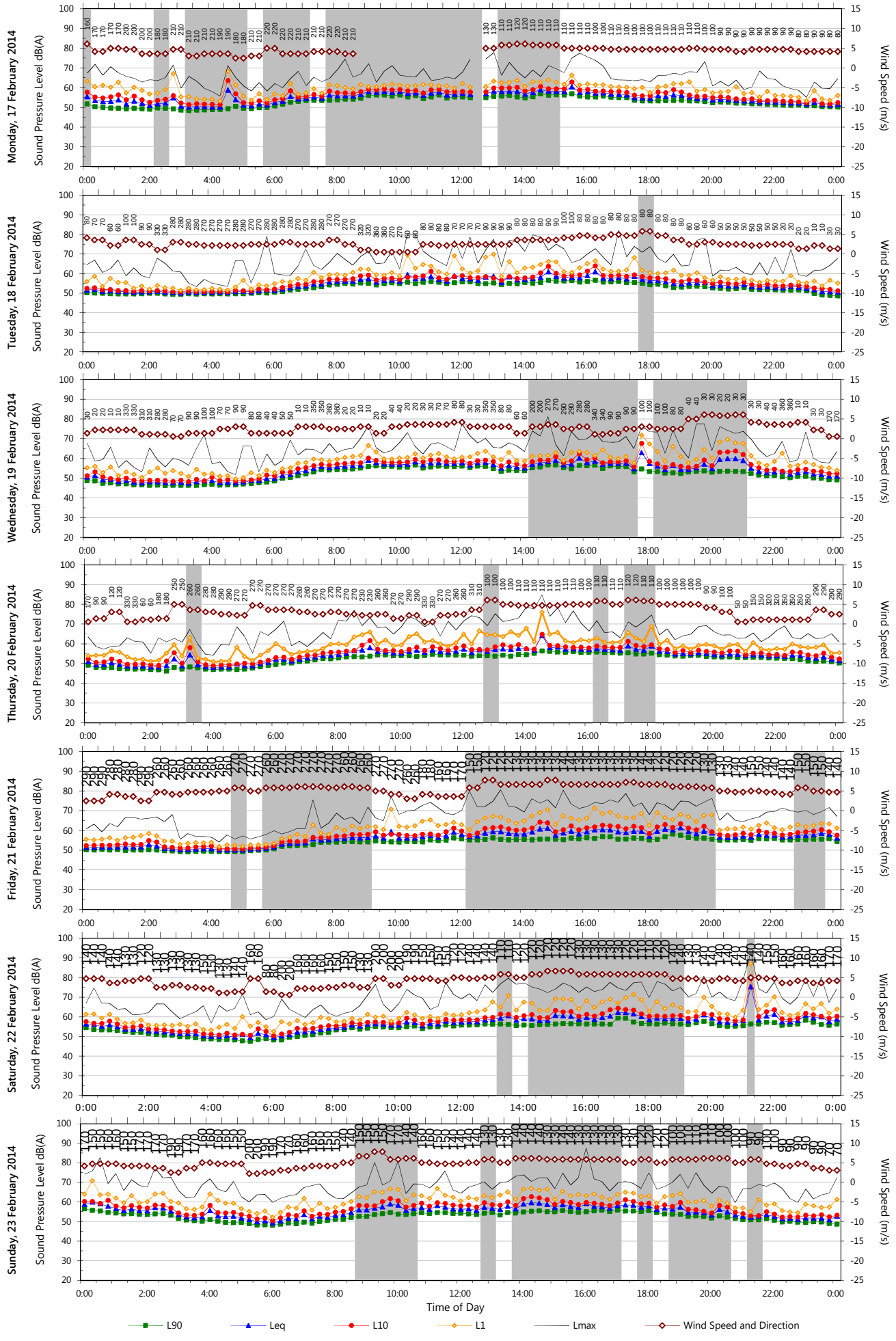

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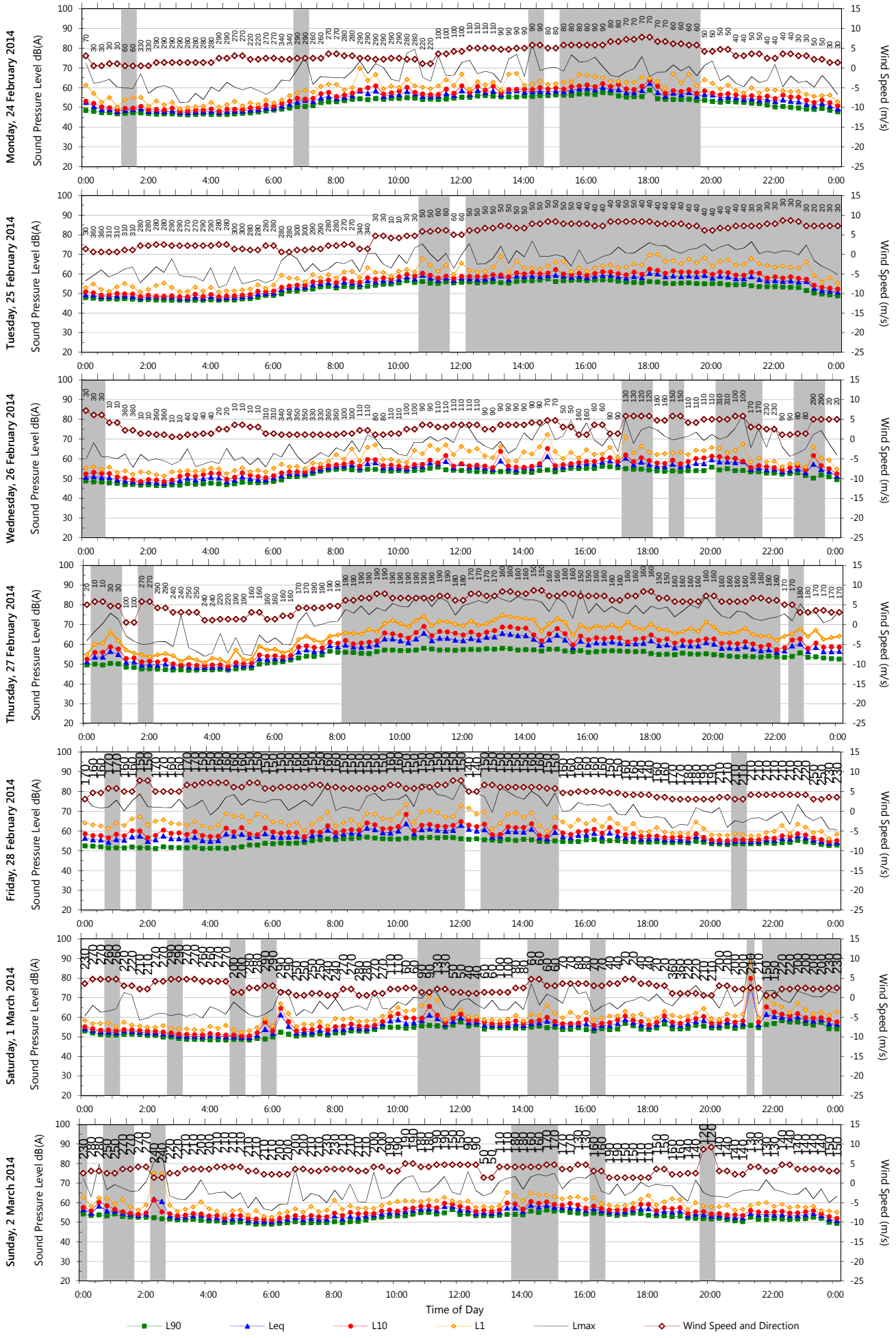

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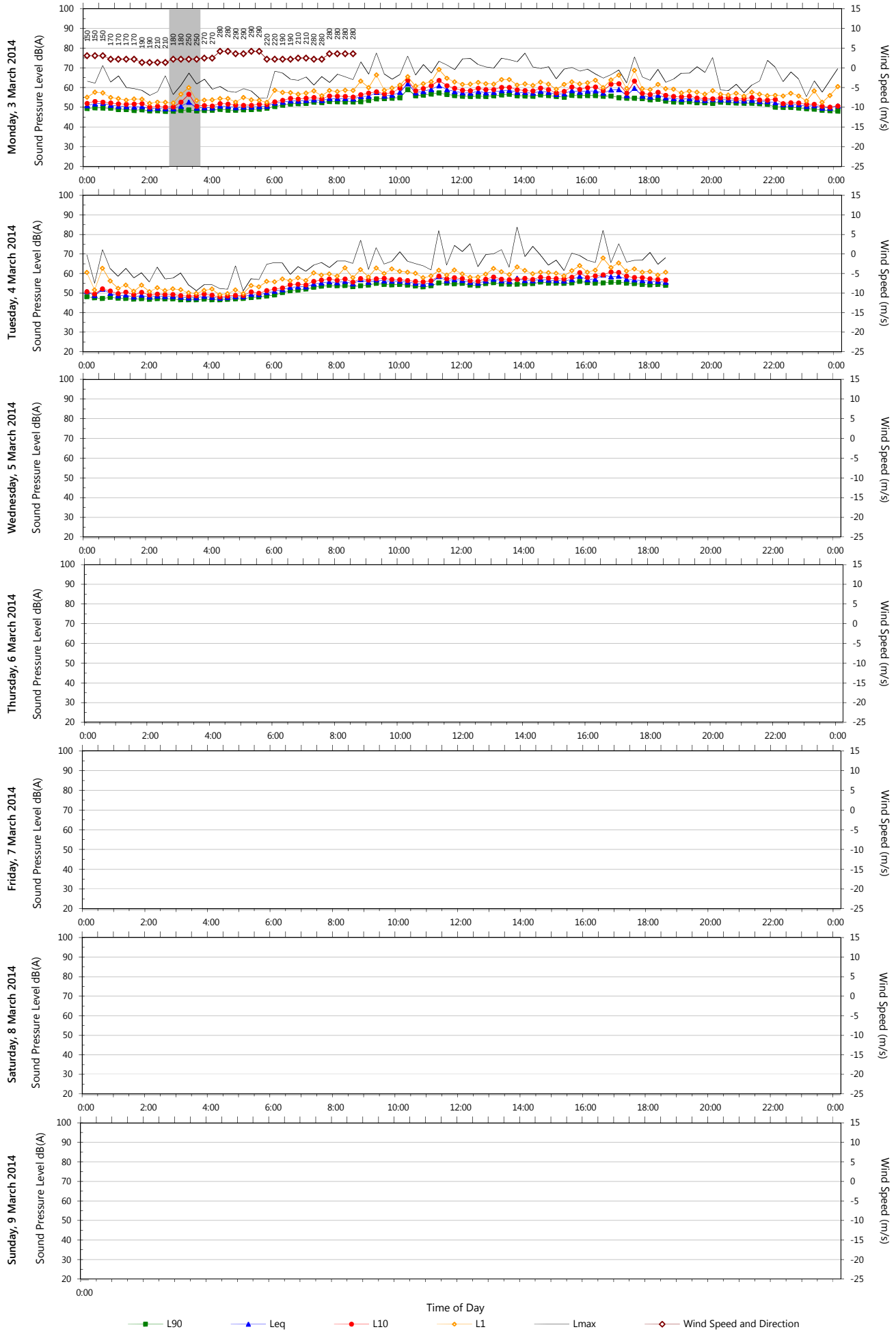

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