Contractor

Forth Crossing Bridge Constructors

HOCHTIEF Solutions
American Bridge International
DRAGADOS
Morrison Construction

Project

FORTH REPLACEMENT CROSSING

Document title

VIBRATION MONITORING REPORT

AUGUST 2015

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Contents

Appendices:

INTRODUCTION

1.1. Monitoring of construction vibration is being undertaken by FCBC during the construction of the new Forth Crossing and associated road network. This report covers the month of August 2015. The objective of this report is to detail the vibration monitoring that has been undertaken across the site during this period, which has been done so in accordance with the Code of Construction Practice (CoCP), and Noise and Vibration Management Plan (NVMP).

1.2. FCBC carefully risk assesses noise & vibration likely to result from all construction activities, through the production of Plans for Control of Noise & Vibration (PCNVs). During the preparation of PCNVs, vibration prediction assessments are made. These assessments illustrate that no construction plant, equipment or methodology to be used by FCBC are envisaged to induce any levels of vibration at sensitive receptors that would exceed the vibration threshold levels stated in the CoCP. These assessments/predictions have been validated by means of the vibration monitoring results displayed in this report.

2. MONITORING SUMMARY

2.1. Due to the location and sensitivity of vibration monitoring equipment, the exceedances presented in the graphs included in the appendices of this report do not represent levels generated by construction, but rather show local interference around the monitoring equipment. This can include, for example, Residential activity, or indeed any significant movements occurring close to the monitoring equipment.

2.2. According to the BS5228-2 (2009) there is minimal documented proof of actual damage to structures or their finishes resulting from construction, and damage resulting solely from well-controlled construction and demolition vibrations is rare. There are many other mechanisms which cause damage, especially in decorative finishes, and it is often incorrectly concluded that vibrations from construction and demolition sites are to blame. In many cases it is not possible to ascertain the exact source of vibration, though it is possible to rule out construction as a source on an activity basis.

2.3. The works carried out in each of the various construction work areas as well as the related vibration assessments are summarised in Appendix A.

2.4. Considering the distances between the various construction work areas and sensitive receptors as well as working methods utilised, the risk of any damage to structures or nuisance to residents occurring as a result FCBC construction related vibration is highly unlikely.

2.5. The number of threshold exceedances at the various vibration monitoring stations during the period in question are shown in Table 1 below.

Table 1: Exceedances of thresholds set out in the CoCP

August 2015

Location	PPV Exceedance		VDV Exceedance	
	Continuous ($5\ mm.s^{-1}$)	***Intermittent ($10\ mm.s^{-1}$)***	***Day ($0.4\ m.s^{-1.75}$)***	***Night ($0.2\ m.s^{-1.75}$)***
Linn Mill	15	3	1	1
Butlaw Fisheries	1	0	0	0
Clufflat Brae	11	0	0	0
Dundas Home Farm	0	0	0	0
Echline	1	0	0	0
Inchgarvie Lodge	0	0	0	0
Scotstoun	0	0	0	0
Springfield	4	2	0	0
Tigh-Na-Grian	3	1	0	4
Whinnyhill	3	1	0	0

2.6. Peak Particle Velocity (PPV) is used to measure vibration through a solid surface. When a vibration is measured, the point at which the measurement takes place can be considered to have a particle velocity. This particle vibration will take place in three dimensions (x, y and z).

2.7. The Peak Particle Velocity is the highest velocity that is recorded during a particular event, and as such is appropriate for the measurement of activities such as blasting, piling and compacting. The thresholds for the Forth Replacement Crossing are 5 $mm.s^{-1}$ for continuous construction (e.g. piling), and 10 $mm.s^{-1}$ for intermittent construction (e.g. blasting).

2.8. These thresholds are set to protect against building damage. For this monitoring period, all the exceedances have been investigated thoroughly and appear to have been generated as a result of standalone, instantaneous events arising from local interferences, the exact source of which remains unknown.

2.9. Vibration Dose Value (VDV) is a metric used in vibration monitoring. It is calculated by taking the fourth root of the integral of the fourth power of acceleration after it has been frequency-weighted. The frequency-weighted acceleration is measured in $m.s^{-2}$ and the time period over which the VDV is measured is in seconds. This yields VDVs in $m.s^{-1.75}$.

2.10. The vibration dose value (VDV), a cumulative measurement of the vibration level received over an 8-hour or 16-hour period, is recommended in BS 6472 as the appropriate measure to evaluate human exposure to vibration in buildings in residential and other uses.

2.11. During the monitoring period, vibratory rollers and whacker plates were used intermittently at several locations around the site. No exceedances were recorded as a result of the use of this equipment, where exceedances did occur it resulted from non-project related activity around the monitor.

2.12. In addition, detailed investigation of all exceedances (i.e. review of PPV levels over 30 seconds periods) has shown that each resulted from isolated, non-construction related events, which likely occurred close to the monitoring station.

2.13. Within the Appendix B, there are short gaps of missing data in the PPV and VDV graphs. These occurred due to a number of power supply problems and corrupt files.

3. CONCLUSION

3.1. Considering the distance between FCBC construction works and sensitive receptors, the methods of working utilised and programme of works. The risk of damage to structures or nuisance to residents resulting from vibration is highly unlikely.

3.2. Due to the location and sensitivity of vibration monitoring equipment, the exceedances presented in the graphs included in the appendices of this report are unlikely to be generated by construction, but rather show local interference and maintenance around the monitoring equipment.

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APPENDIX A – MONITORING LOCATIONS & VIBRATION ASSESSMENTS FROM RELEVANT PCNVs

Table 2: Monitoring Locations

Ref.	Monitoring Location	Crossing or Network	Main Construction Activities During August 2015
M1	Whinny Hill	Network	• Earthworks/Fill placement • New Ferrytoll Road • FT03&FT04 deck works • FT09 works • FT19 Retaining Wall • Roadworks
M3	Tigh-Na-Grian	Crossing	• Central Tower rebar, formwork, concreting works deck table installation works • North Tower rebar, formwork, concreting works deck table installation works • Pier N1 rebar formwork & concrete works • AVN works
M7	Butlaw Fisheries	Crossing	• Pier S1 rebar, formwork & concrete works • Rebar installations at Pier S2 • Central Tower rebar, formwork, concreting works deck table installation works • South Tower rebar, formwork, concreting works deck table installation works
M10	Inchgarvie Lodge	Crossing	• Launch – Install formwork and rebar • Pier S1 rebar,formwork & concrete works • Rebar installations at Pier S2 • Central Tower rebar, formwork, concreting works deck table installation works • South Tower rebar, formwork, concreting works deck table installation works • Main Carriageway earthworks
M11	Linn Mill	Network (close proximity to Crossing)	• Launch – Install formwork and rebar. • No night time or Sunday construction in the vicinity • Excavation, Break rock, fill/trim mainline & fill launch
M13	Clufflat Brae	Crossing / Network	• Launch – Install formwork and rebar • No night time or Sunday daytime construction in vicinity.

M14	Springfield	Network	• Launch – Install formwork and rebar • No night time or Sunday daytime construction in vicinity. • Earthworks South Abutment area • Excavation, Break rock, fill/trim mainline & fill launch
M15	Echline	Network	• Launch – Install formwork and rebar • No night time or Sunday construction in the vicinity • Earthworks South Abutment area • Excavation, Break rock, fill/trim mainline & fill launch
M16	Scotstoun	Network	Footpath works • Utility works • Bridge beam painting ESQ04 • B800 North road works including bridge works
M17	Dundas Home Farm	Network	• Utility works • Bridge beam painting ESQ04 • B800 South roadworks including bridge works • Main carriageway works

Table 2: The main construction activities undertaken in the locality of each of the vibration monitors during the period of August 2015.

Table 3: PCNV Predicted PPV & VDV Levels

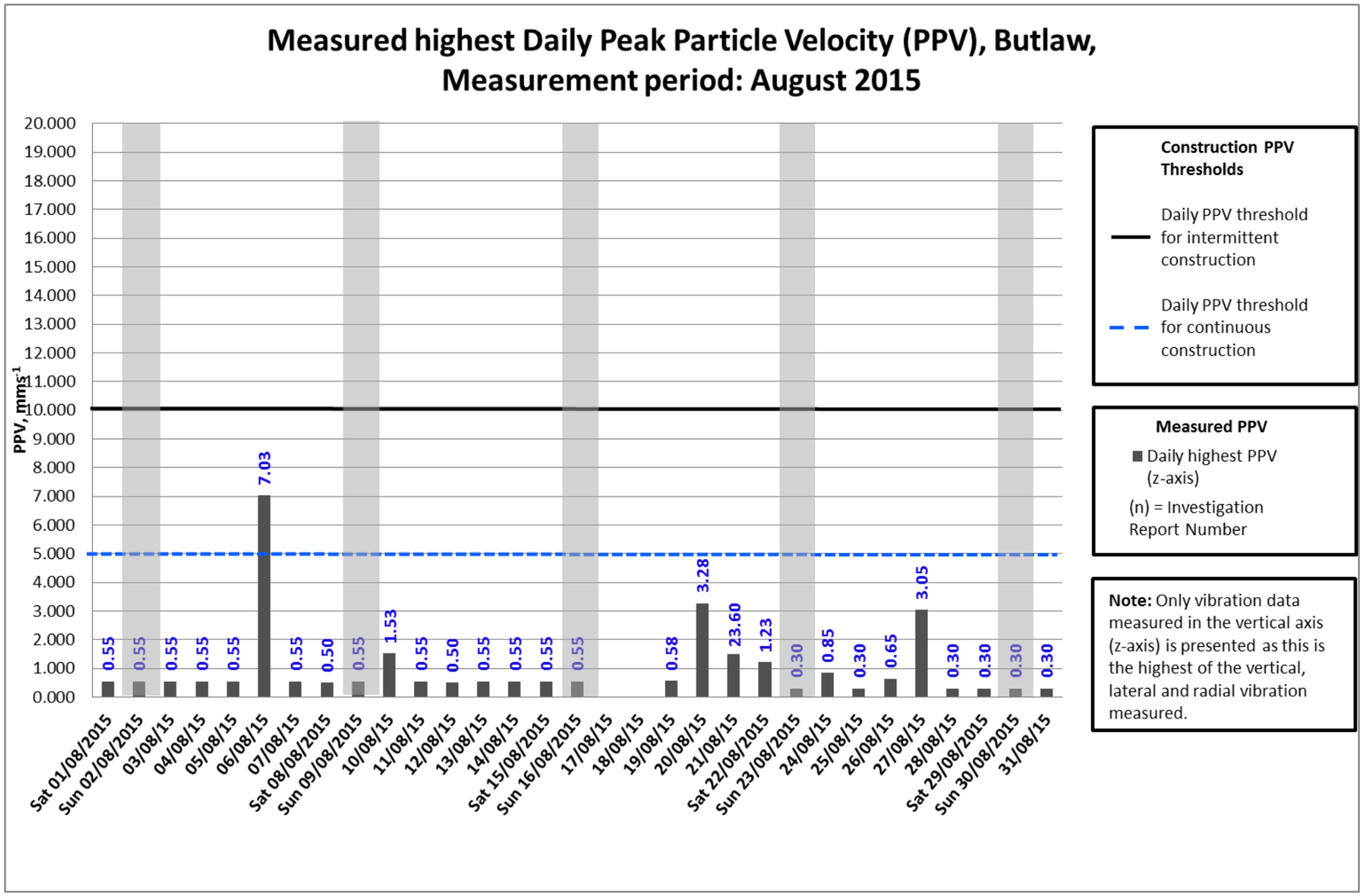
Monitor	Minimum distance from work areas (m)		Type of vibration emitting plant/activity operated at nearest work areas	Worst case predicted vibration levels	
	Day (07:00-19:00)	Night (19:00-07:00)		PPV (mm/s)	eVDV ($m.s^{-1.75}$)
Butlaw Fisheries	130	160	Roller/Whacker	0.44	0.23
Clufflat Brae	40	90	Roller/Whacker	2.44	0.37
Dundas	75	2000	Roller/Whacker	0.98	0.33
Echline	40	1000	Roller/Whacker	2.44	0.37
Inchgarvie Lodge	50	40	Roller/Whacker	1.77	0.33
Linn Mill	60	250	Roller/Whacker	1.36	0.33
Scotstoun	40	2000	Roller/Whacker	2.44	0.37
Springfield	50	300	Roller/Whacker	1.77	0.33
Tigh-Na-Grian	200	200	N/A	-	-
Whinny Hill	180	1800	N/A	-	-

Table 3: The distances from vibration monitors to the closest work areas for both day and night time periods. It also lists worst case PPV and eVDV calculations exhibited at the vibration monitors, resulting from the maximum vibration inducing plant operated at the nearest work areas.

Notes on Table 3

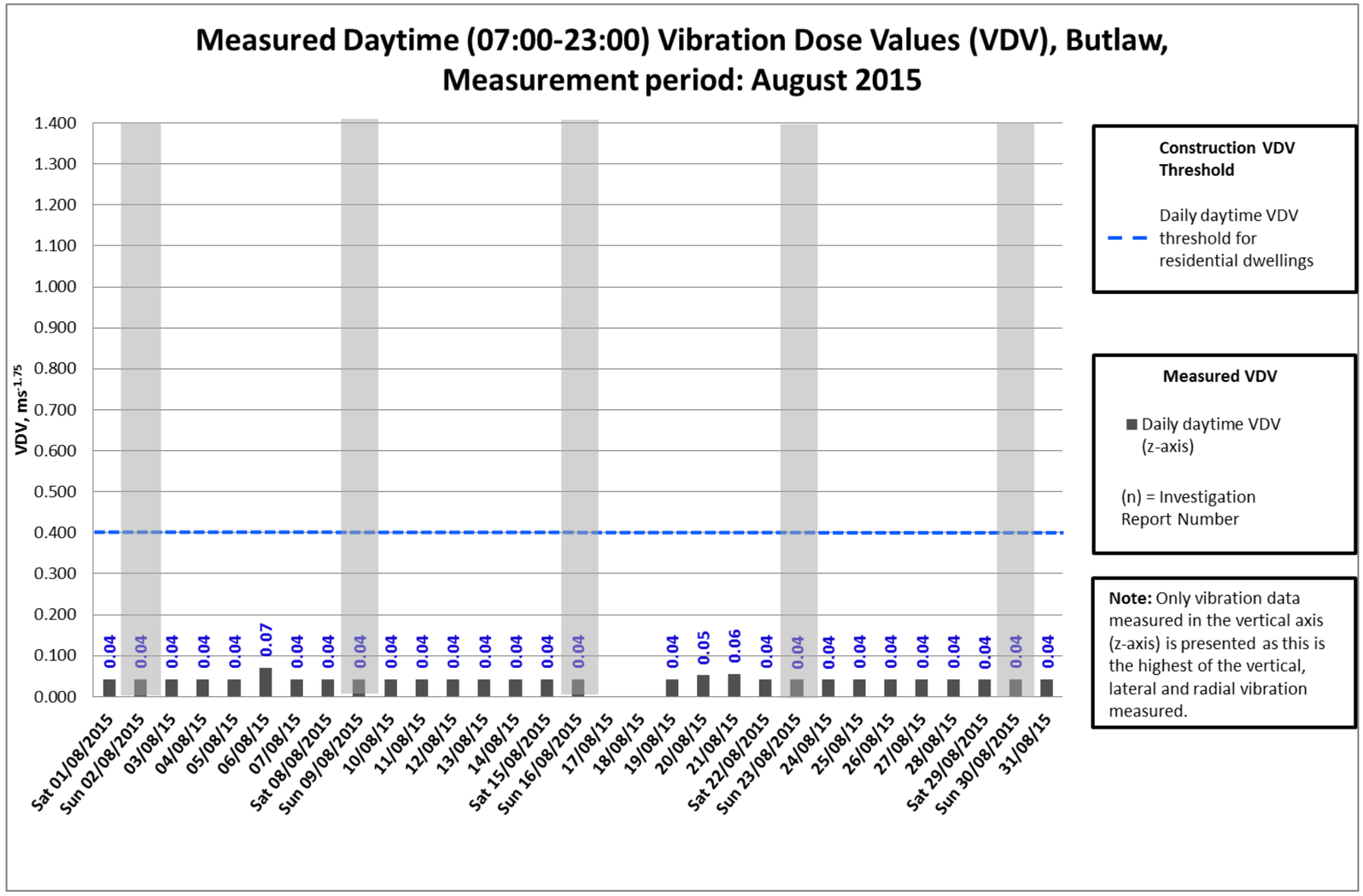
- All plant used during construction activities has been assessed with respect to vibration. The only plant utilised over the period in question considered to generate appreciable levels of vibration was a vibratory roller and a whacker plate (NOTE: Hydraulic rock breakers which typically generate 4.5mm/s @ 5m, 0.4mm/s @ 20m, 0.1mm/s @ 50m have been discounted due to the distances of use from the closest receptors).
- Vibratory rollers were not operated within 20m of any sensitive receptor.
- Whacker plates were not utilised within 40m of any occupied sensitive receptor.
- All roller eVDV values in the table above are based on the worst case scenario of a vibratory roller remaining in continuous operation for 2 hours an average distance (100m) from the nearest occupied receptors.
- All whacker plate eVDV values in the table above are based on the worst case scenario of a whacker plate remaining in continuous operation for 2 hours a minimum distance from the nearest receptor.

APPENDIX B – VIBRATION GRAPHS



Investigations have found the exceedance on the 06/08/2015 was likely to be caused by maintenance on the noise monitor near by the vibration monitor and is unlikely to be caused by construction related activities.

Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.



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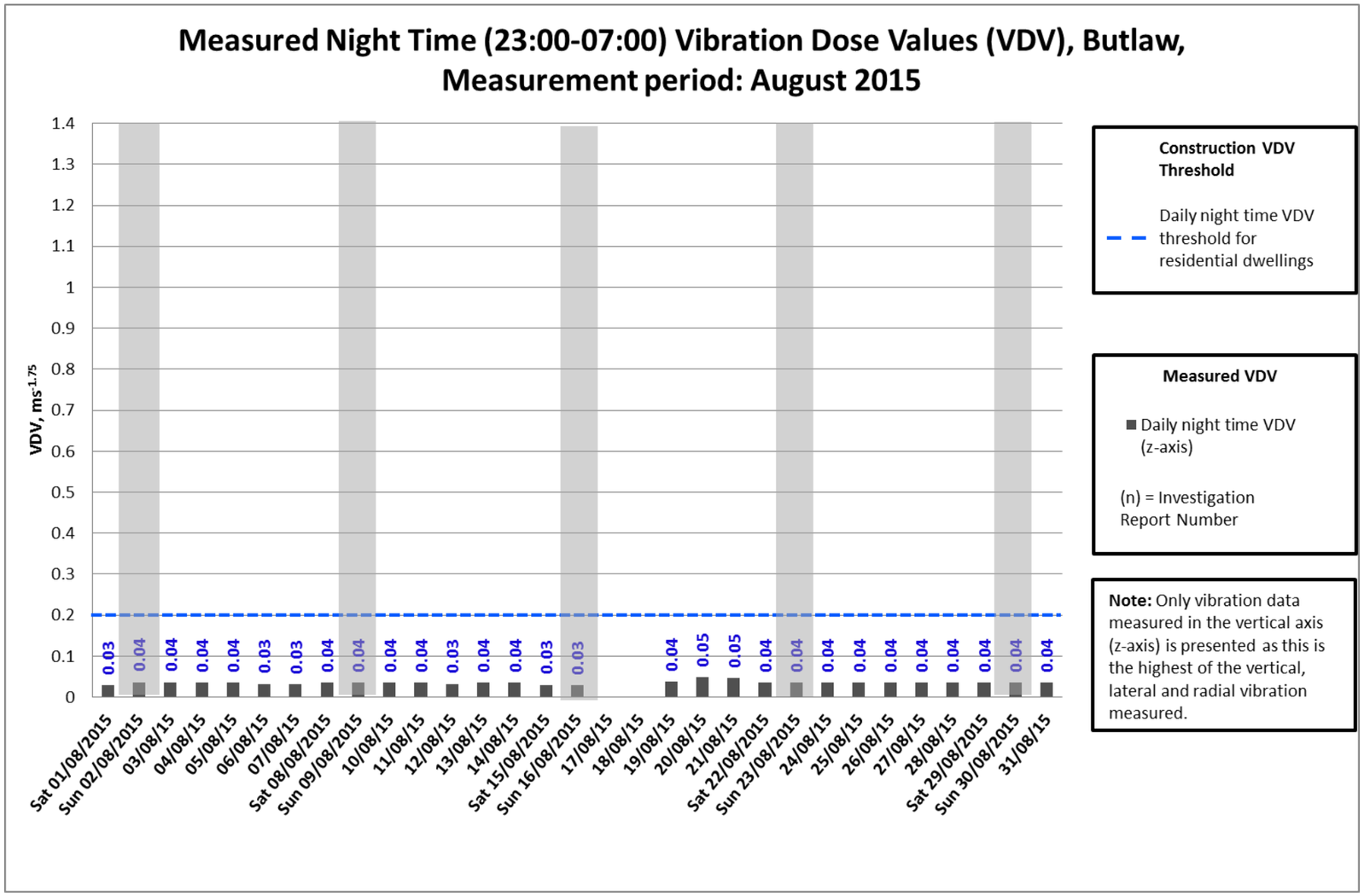

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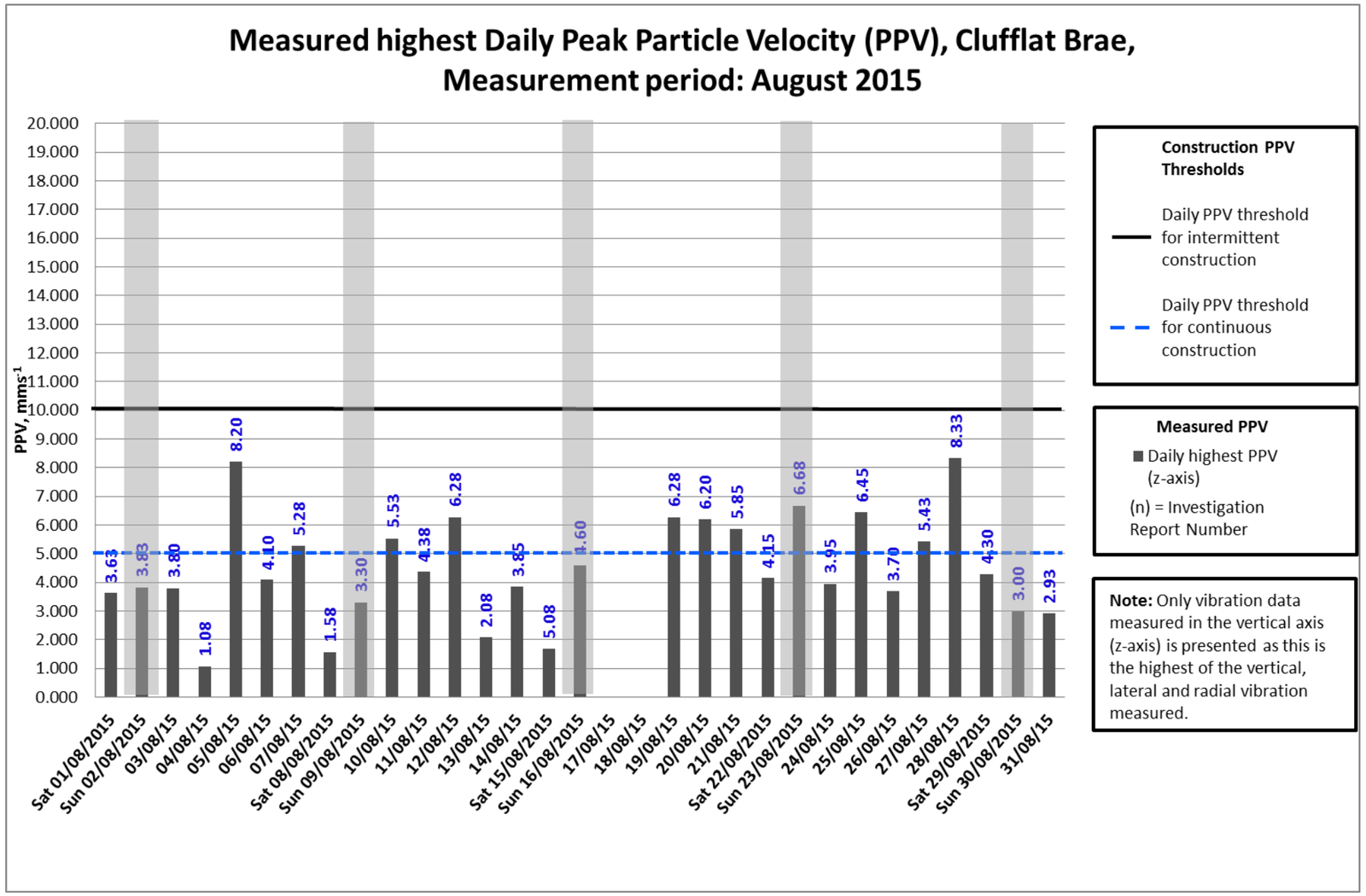
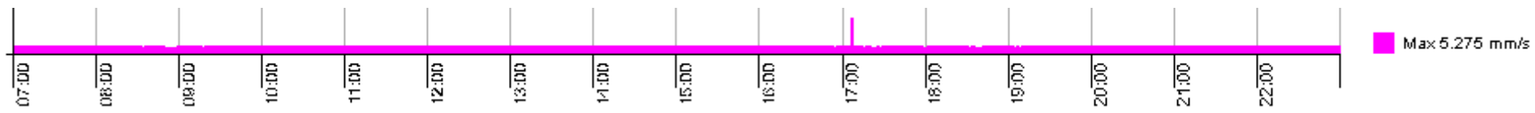
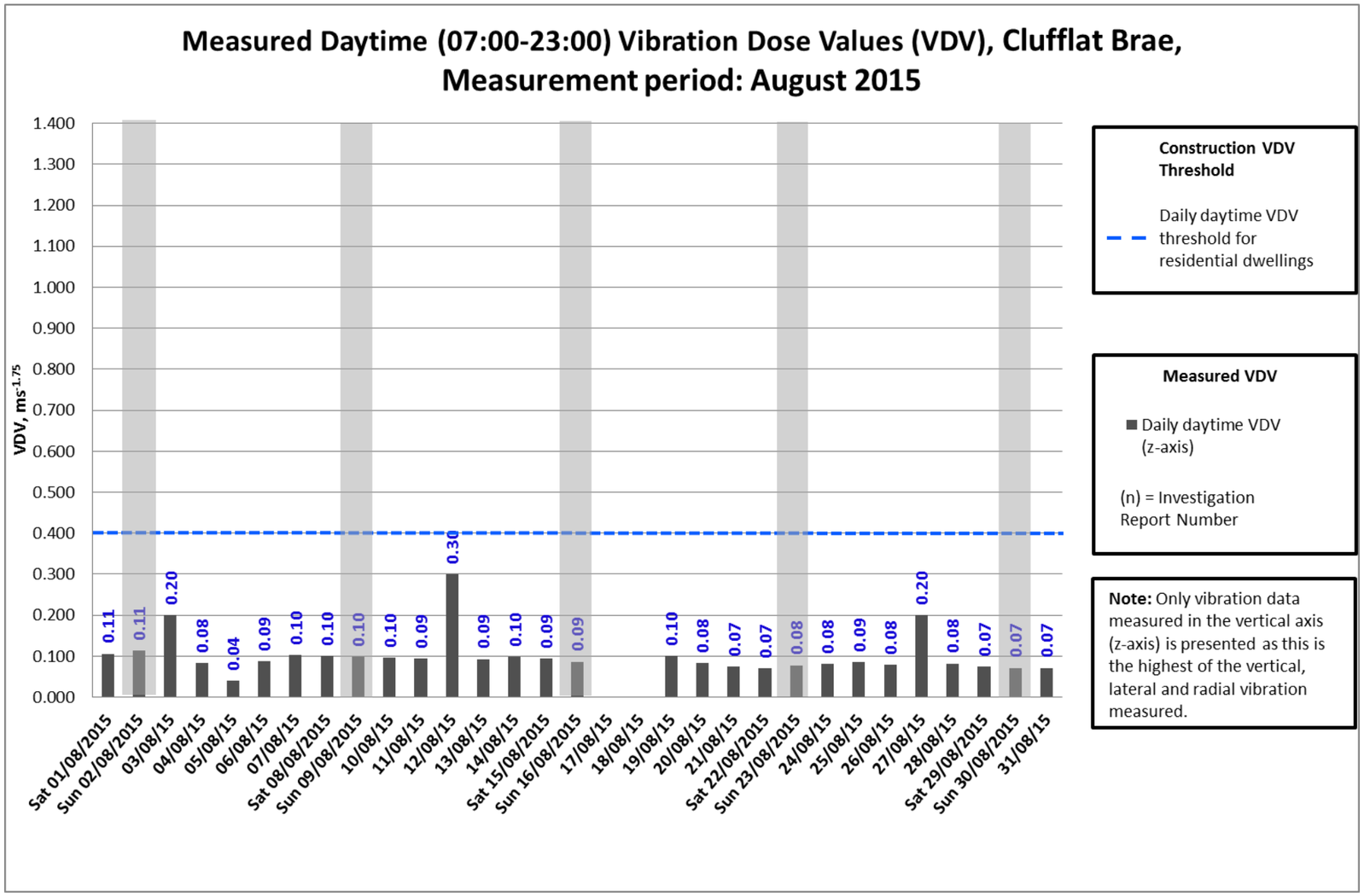




Exceedances on the 05/08/2015, 07/08/2015, 10/08/2015, 12/08/2015, 19/08/2015, 20/08/2015, 21/08/2015, 23/08/2015, 25/08/2015, 27/08/2015 and 28/08/2015 have been investigated and found to be one off isolated events (graph above from the 07/08/2015).
Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.



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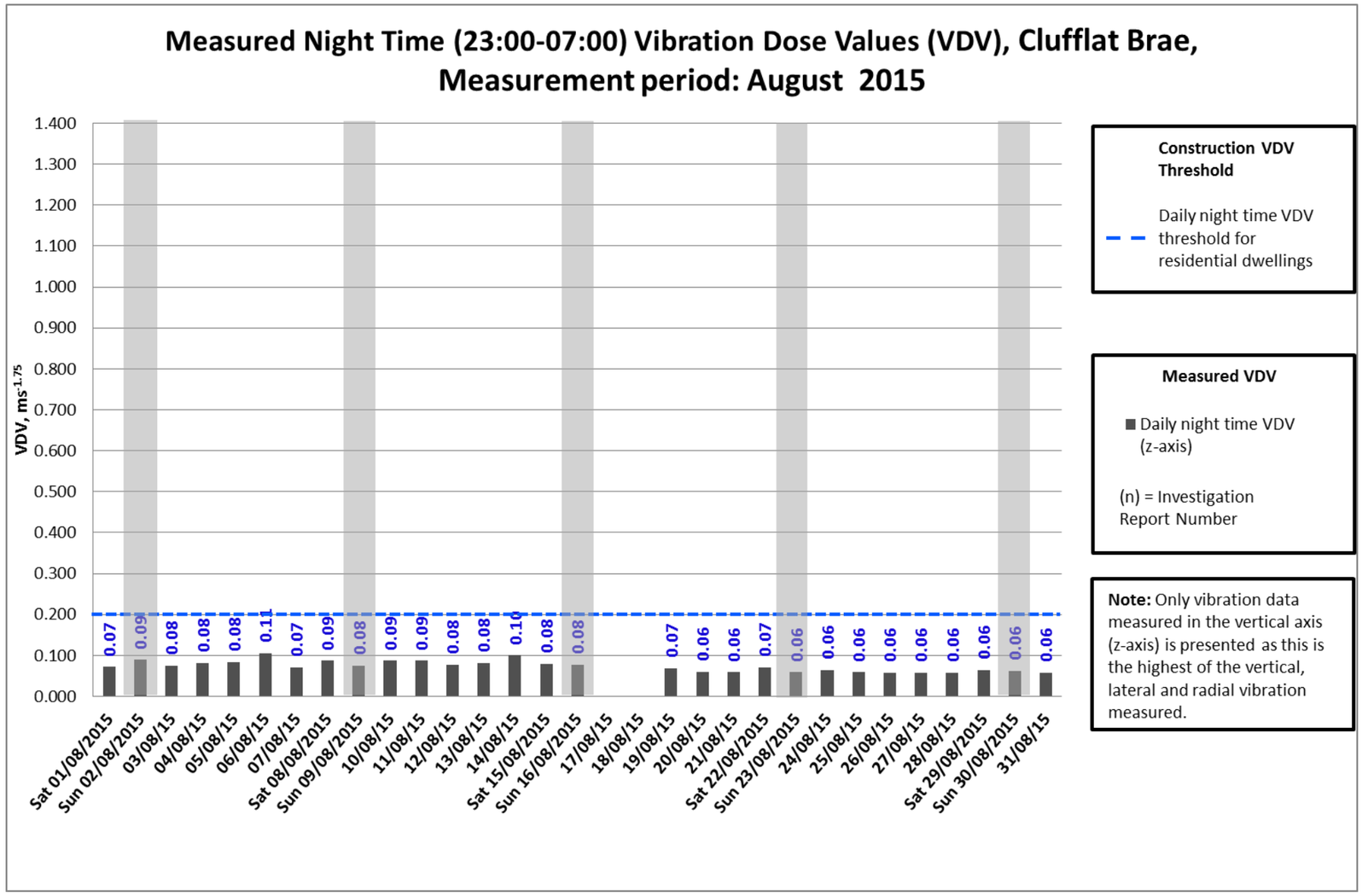

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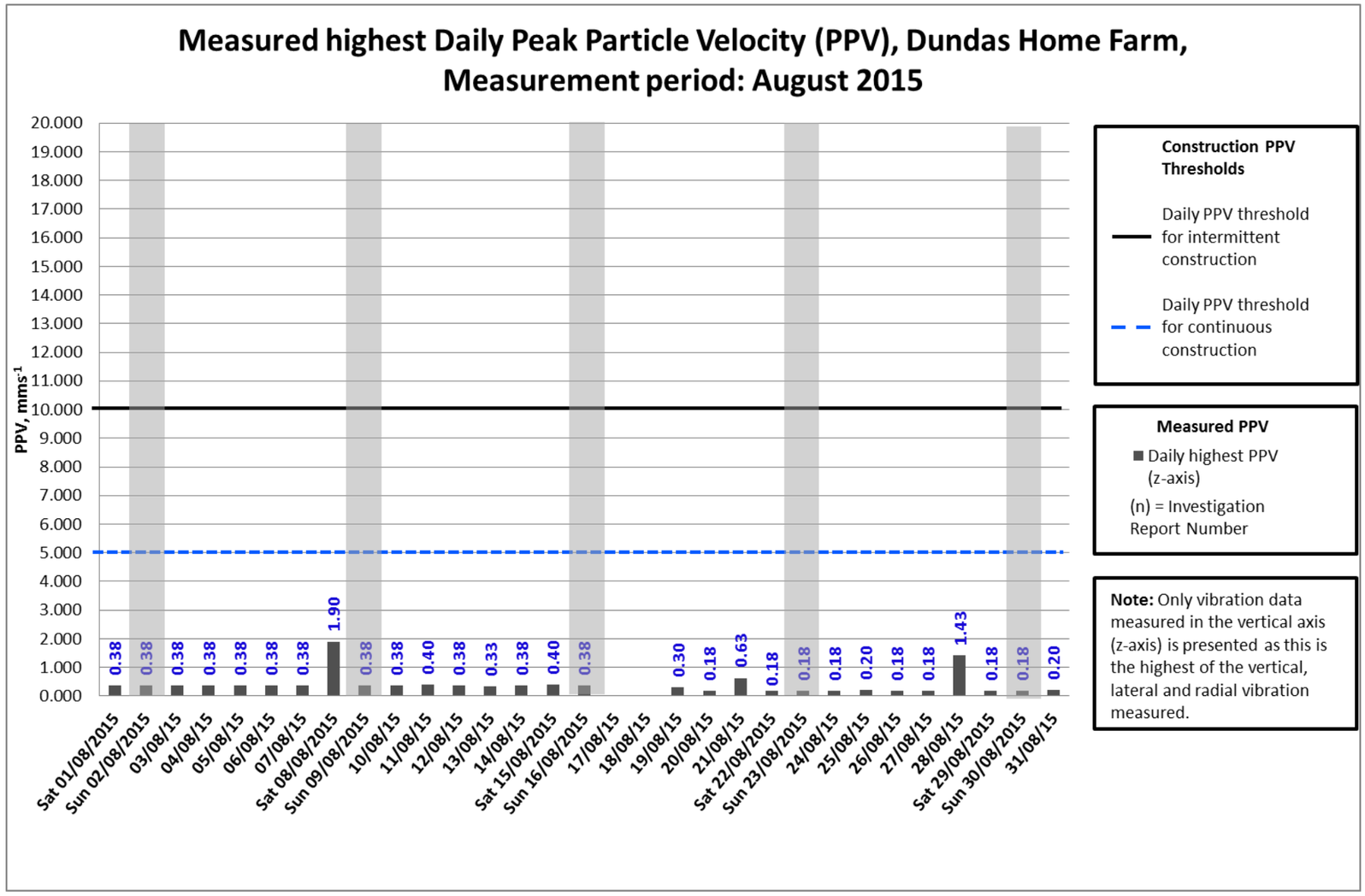

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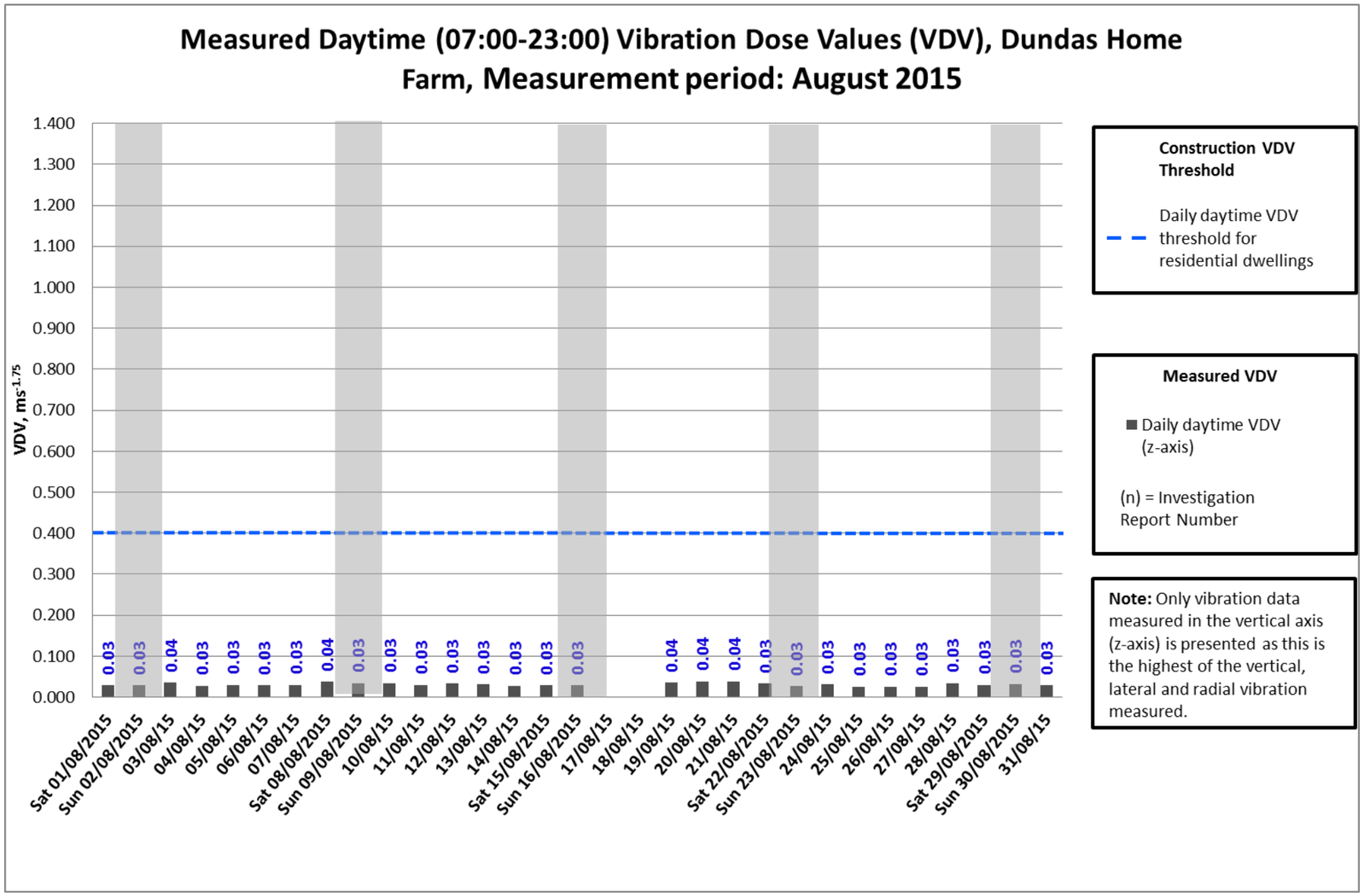

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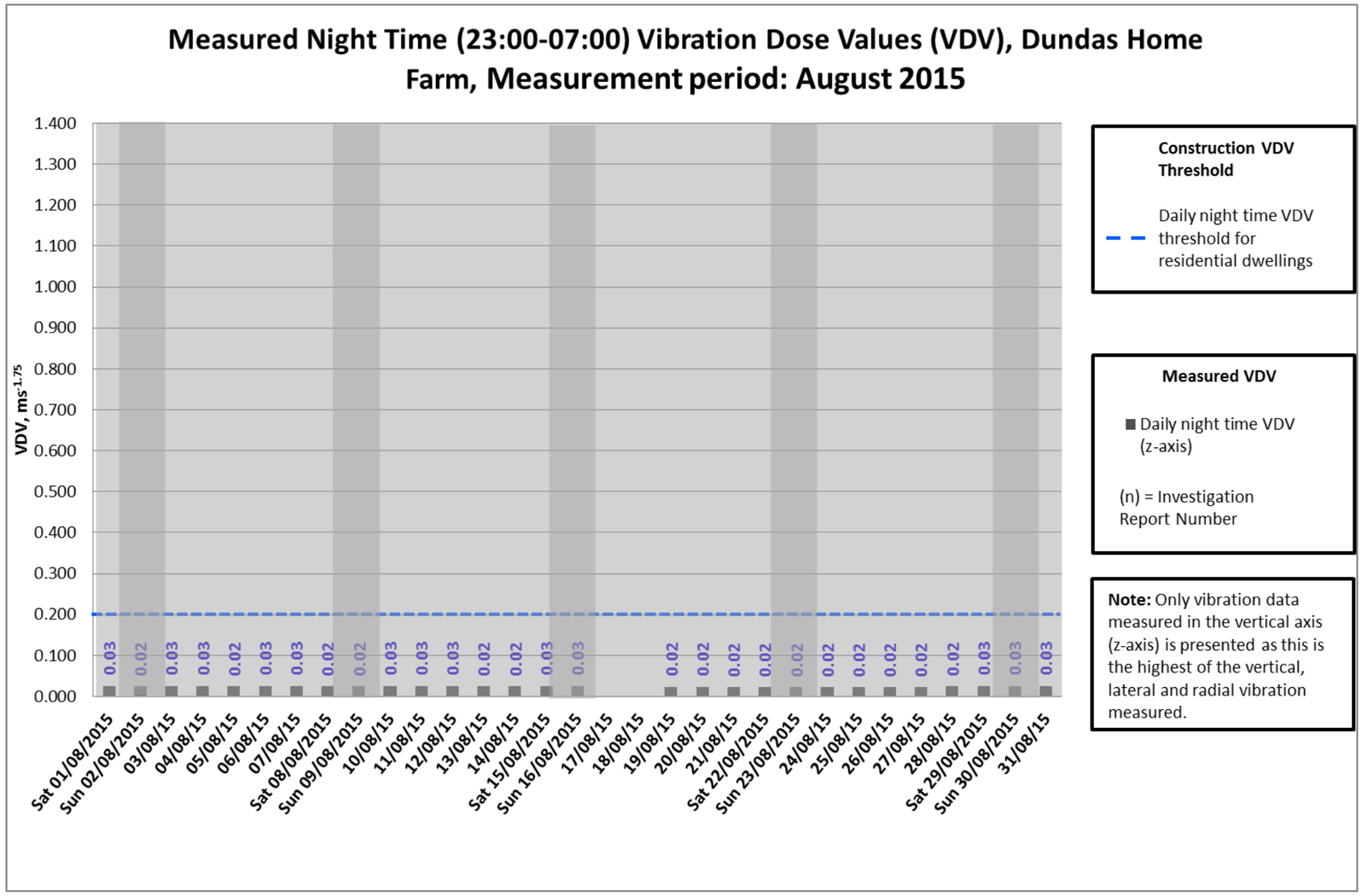
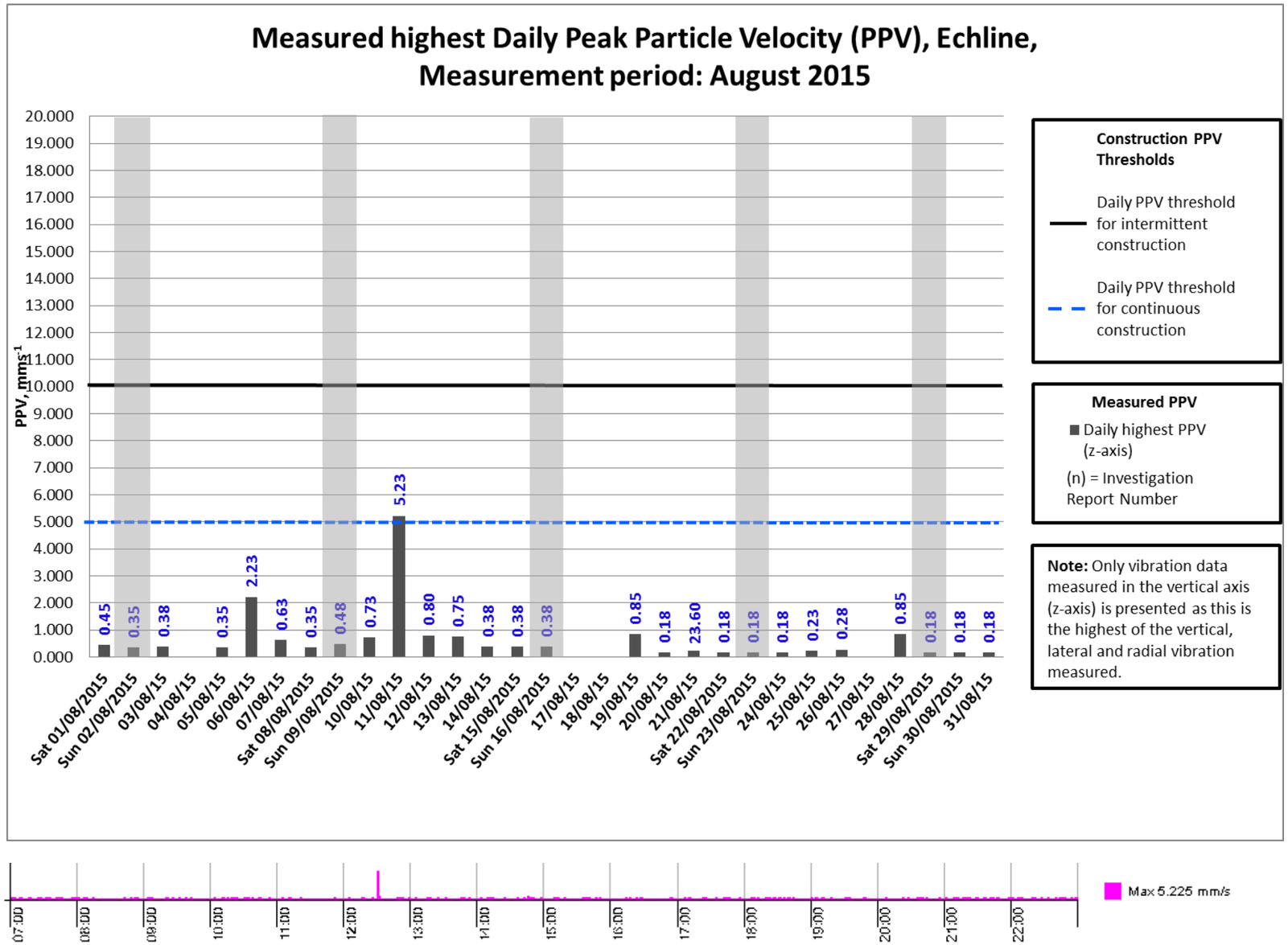
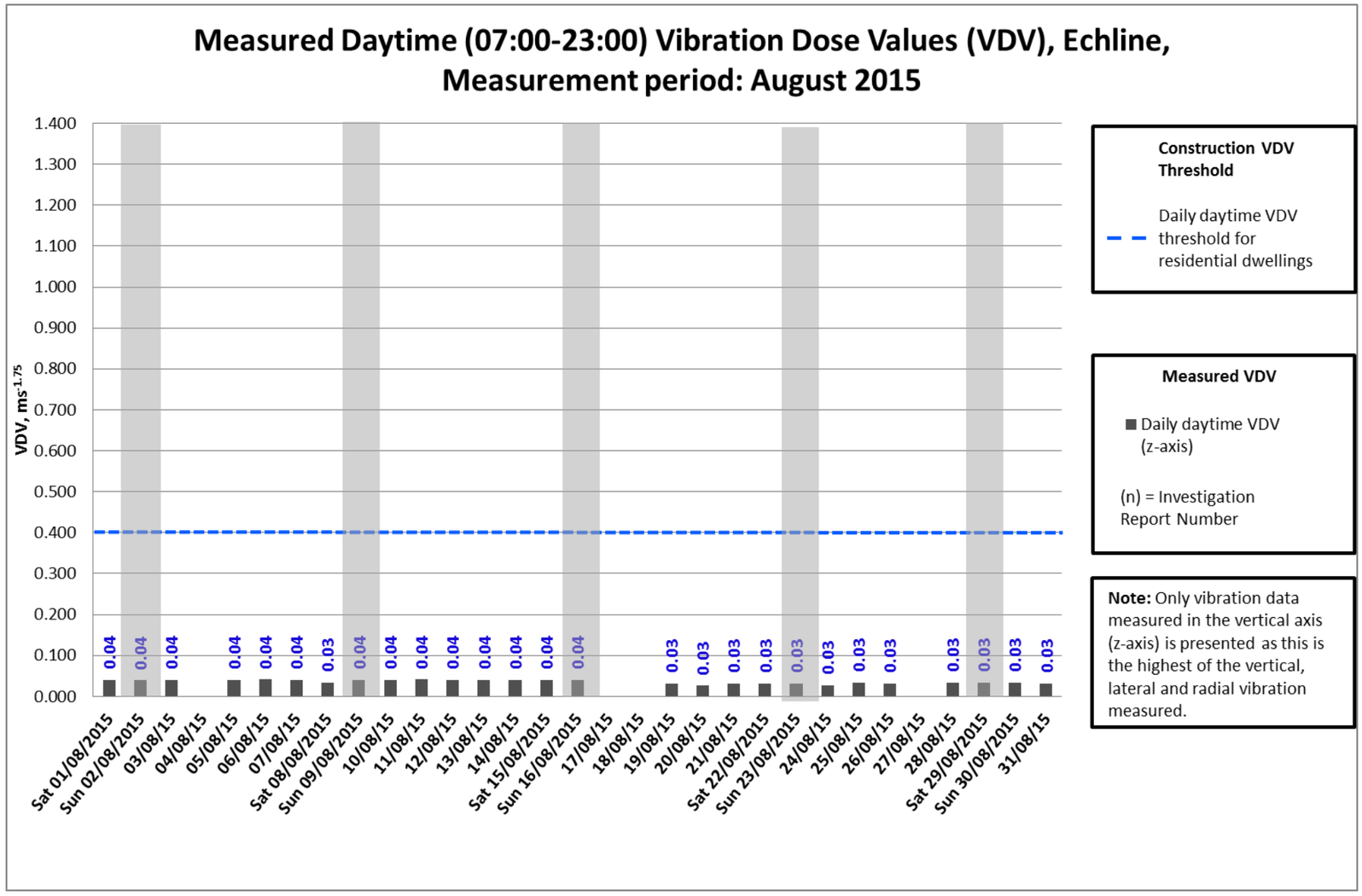


Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.

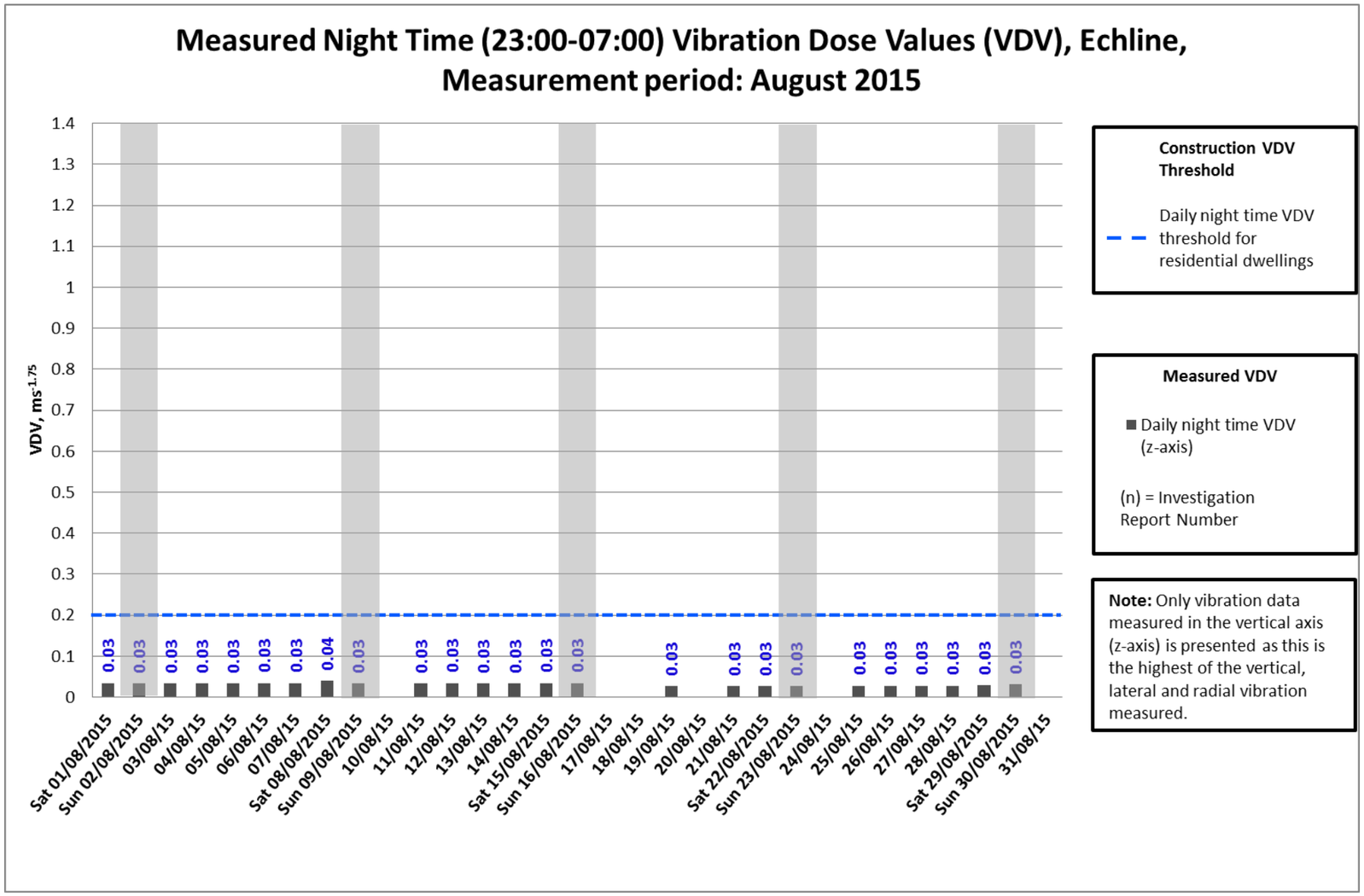


Exceedance on the 11/08/2015 has been investigated and found to be an isolated event which is unlikely to be related to construction activity's(reference graph above from that day).

Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.
Missing data on the 04/08/2015 and on the 27/08/2015 was due to corrupt files on the monitor.



Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.
Missing data on the 04/08/2015 and on the 27/08/2015 was due to corrupt files on the monitor.



Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.
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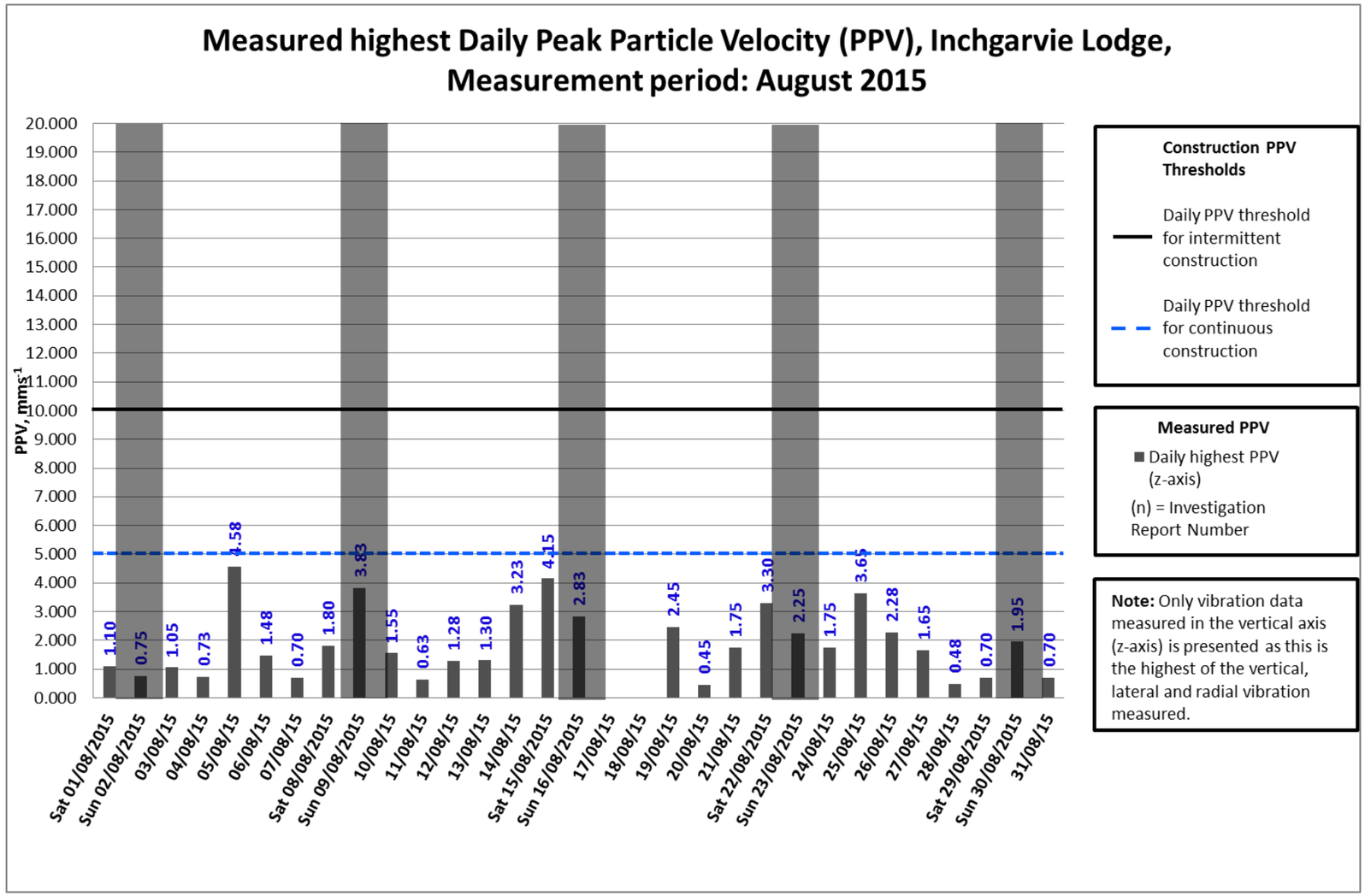

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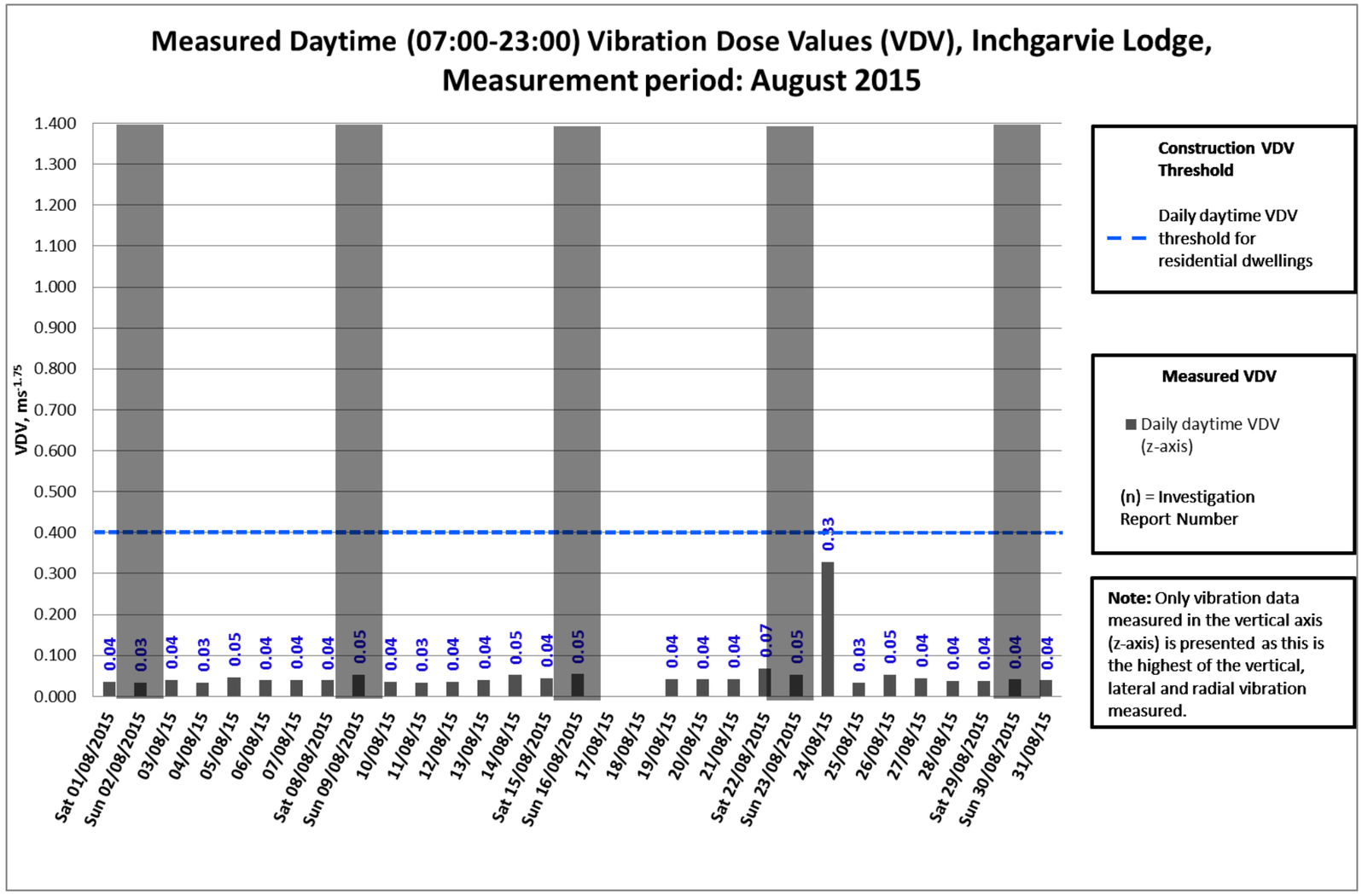

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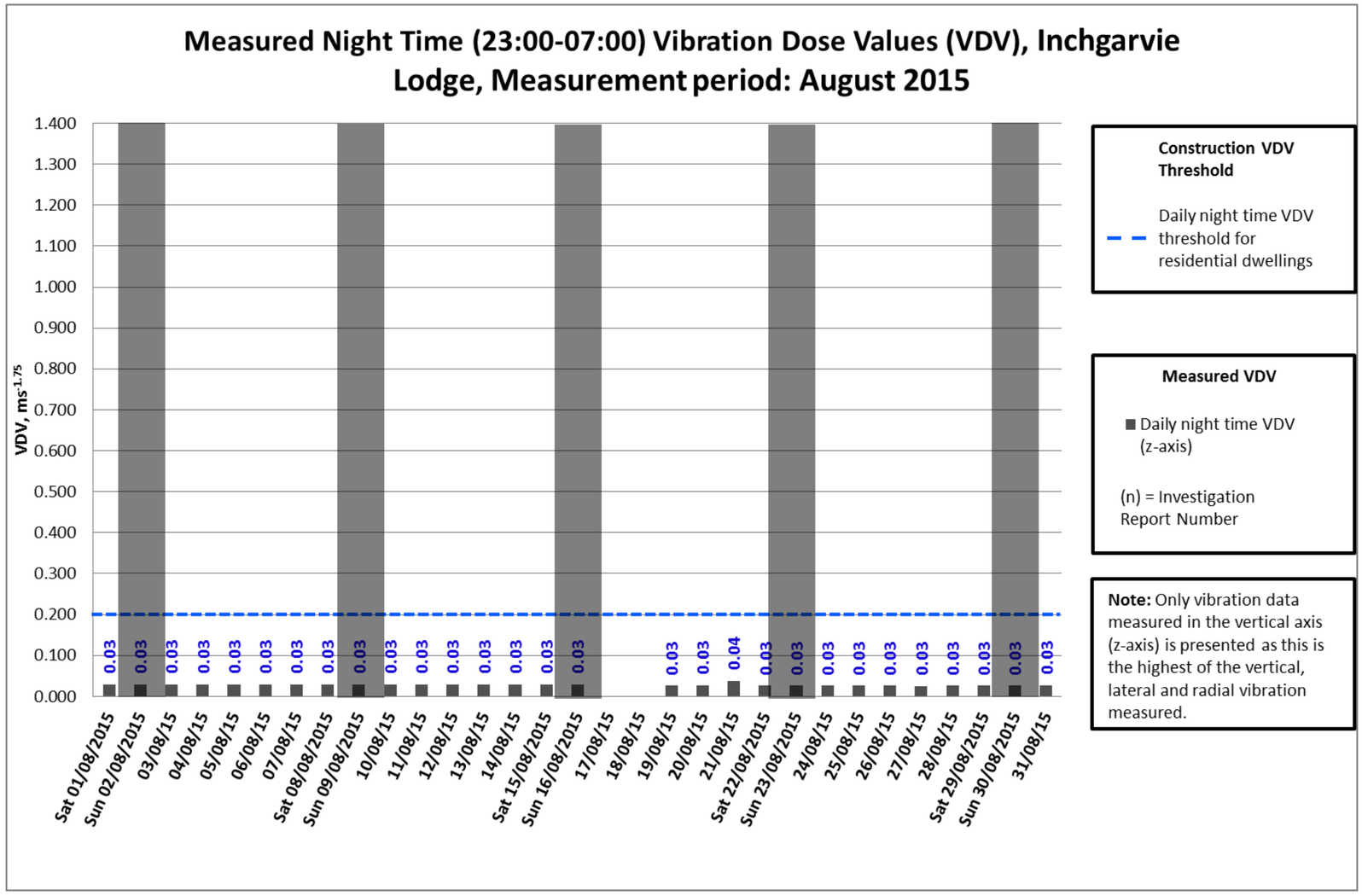

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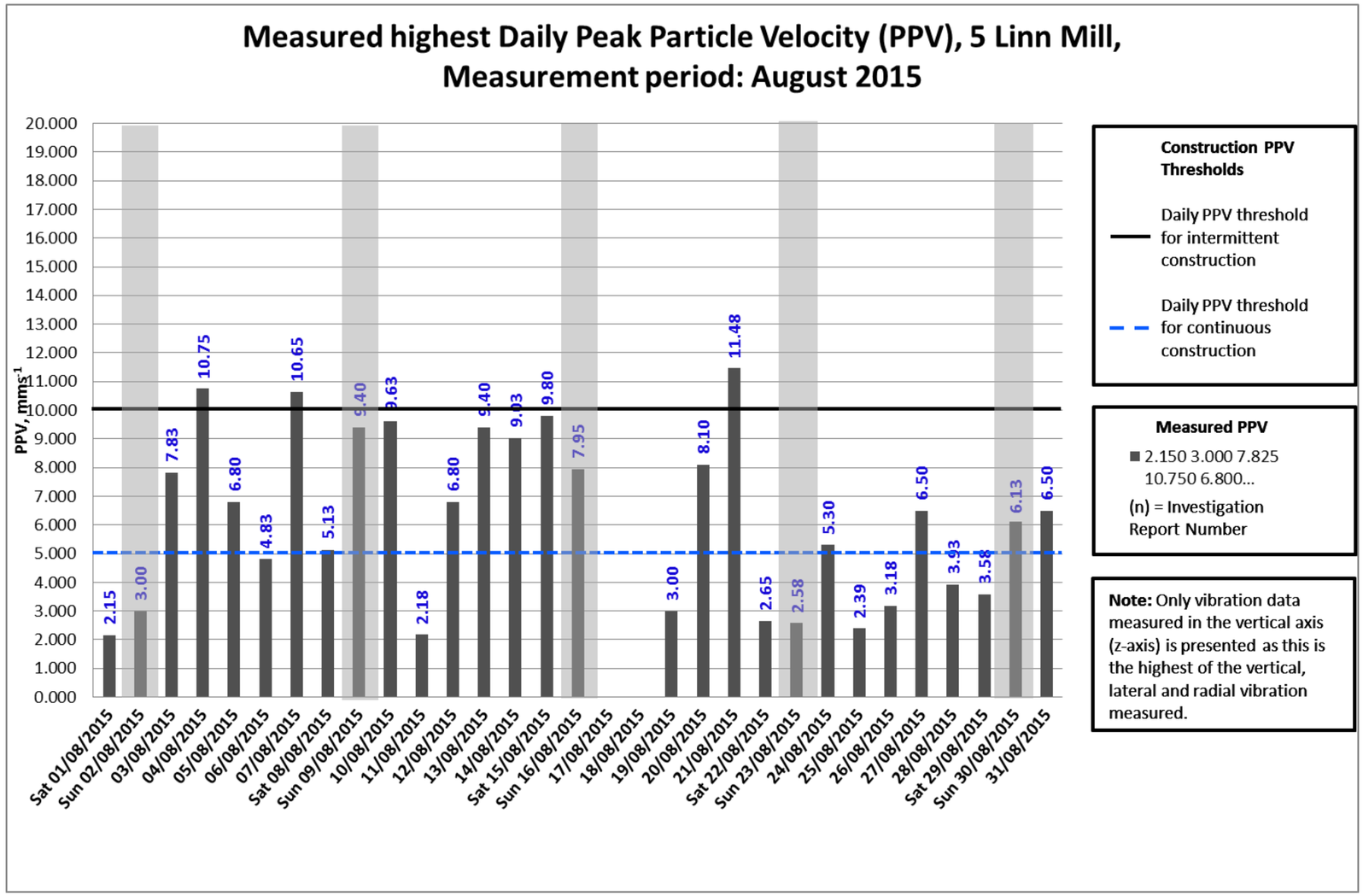
Measured highest Daily Peak Particle Velocity (PPV), 5 Linn Mill,
Measurement period: August 2015
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
2.15
3.00
7.83
10.75
6.80
4.83
10.65
5.13
9.40
9.63
2.18
6.80
9.40
9.03
9.80
7.95
3.00
8.10
11.48
2.65
2.58
5.30
2.39
3.18
6.50
3.43
3.58
6.13
6.50
Sat 01/08/2015
Sun 02/08/2015
03/08/2015
04/08/2015
05/08/2015
06/08/2015
07/08/2015
Sat 08/08/2015
Sun 09/08/2015
10/08/2015
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Sat 15/08/2015
Sun 16/08/2015
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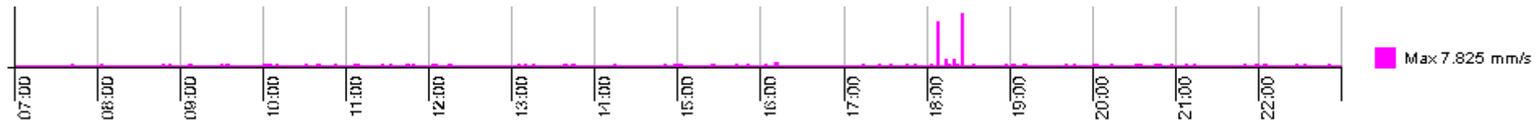
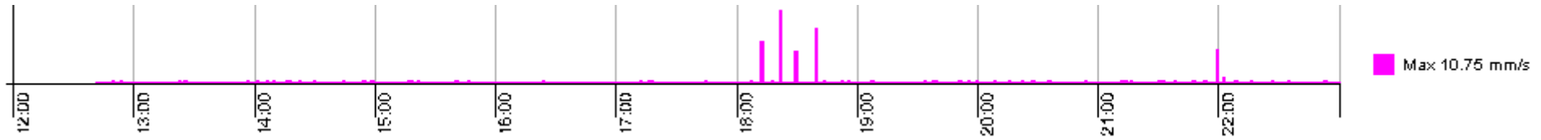
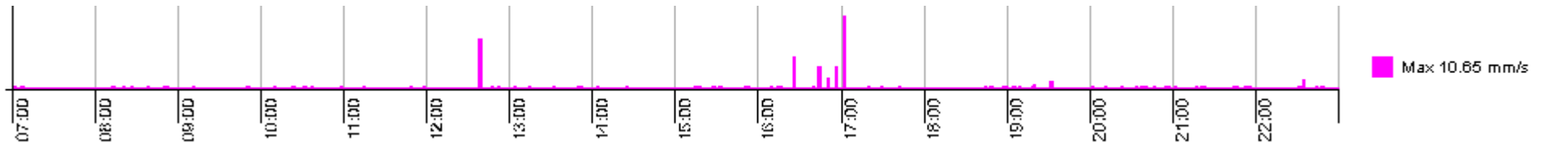
24/08/2015
25/08/2015
26/08/2015
27/08/2015
28/08/2015
Sat 29/08/2015
Sun 30/08/2015
31/08/2015
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
2.150 3.000 7.825 10.750 6.800...
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.



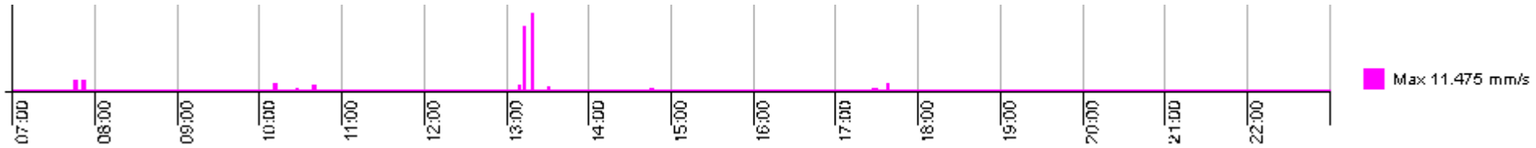
Exceedances on the 03/08/2015, 08/08/2015, 09/08/2015, 10/08/2015, 13/08/2015, 14/08/2015, 15/08/2015, 16/08/2015, 20/08/2015, 21/08/2015, 24/08/2015, 27/08/2015, 30/08/2015 and 31/08/2015 have been investigated and found to be one off isolated events that are likely to be caused by movement near by the monitor rather than construction related activities.



Exceedance on the 04/08/2015 has been investinvestigated and found to be out of construction working hours and is more likely to be caused by movement near by the monitor.

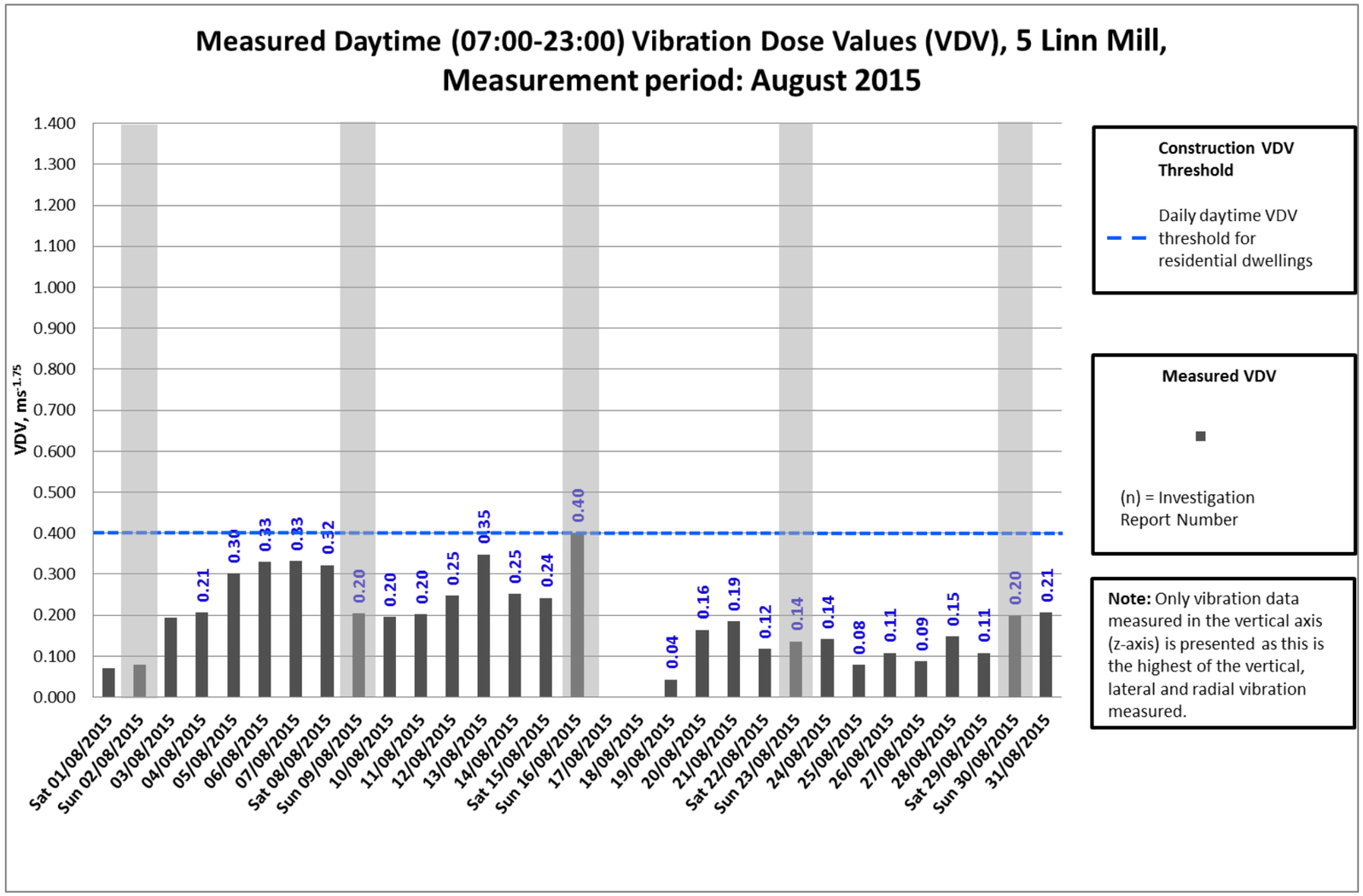


Exceedance on the 07/08/2015 has been investigated and no similar exceedances were observed on the time traces of other vibration monitors in the nearby surrounding area. Investigations also revealed no construction related exceedance at that time on the noise monitor at Linn Mill, situated 45 meters closer to the construction site, which could have helped to identify the source of the plant that may have generated the high vibration levels recorded.



Exceedance on the 21/08/2015 has been investigated and found to be an isolated event with no similar exceedances at that time on the surrounding vibration monitors. Investigations also found no construction related exceedances at that time on the noise monitor at Linn Mill which is 45 meters closer to the construction site

Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.



Exceedance on the 16/08/2015 found on the graph above is out with construction working hours and is unlikely to be construction related and more likely to be movement near by the vibration monitor.

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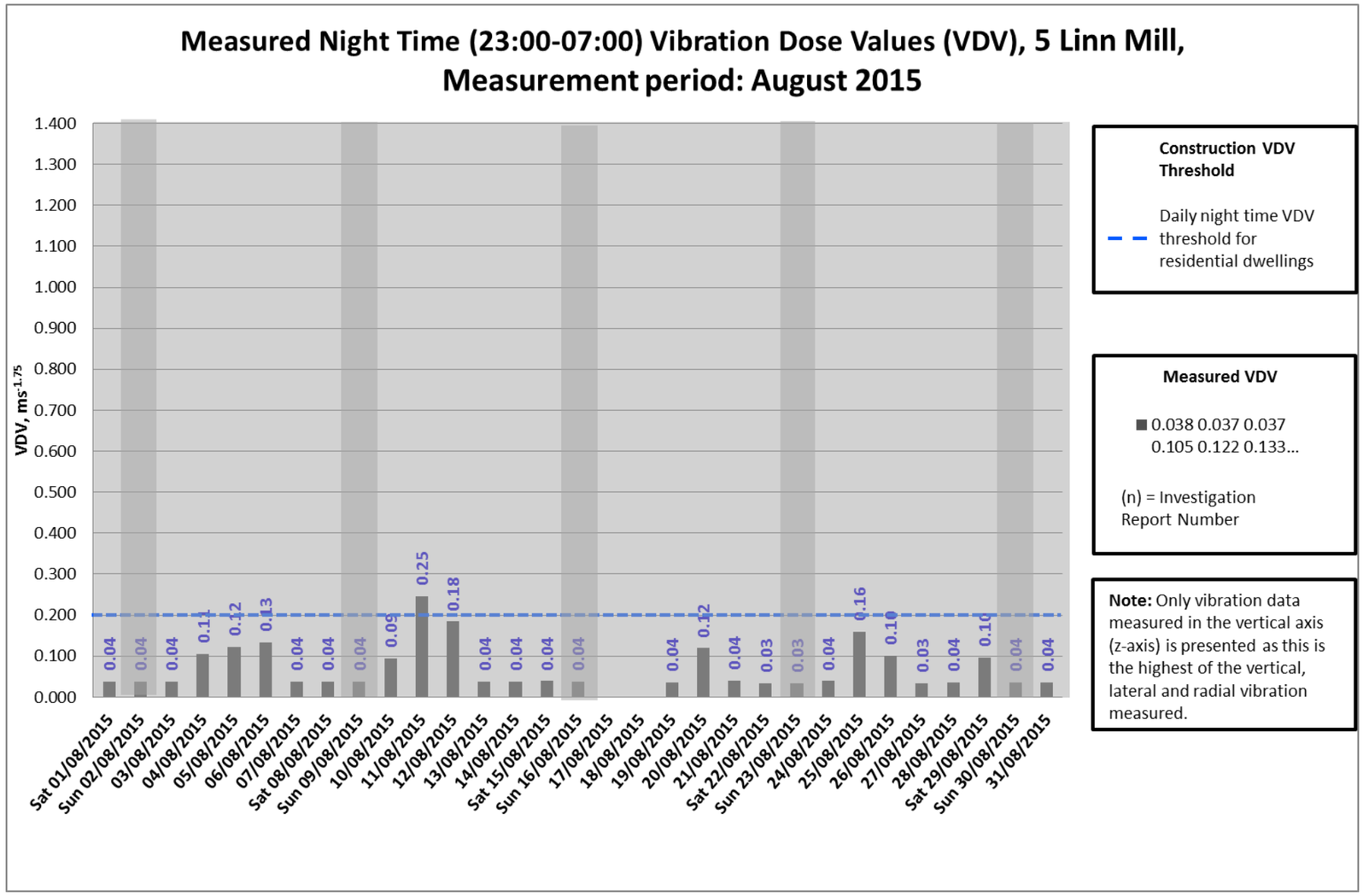
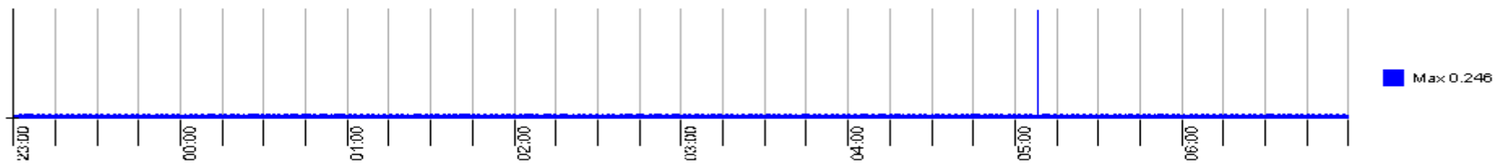
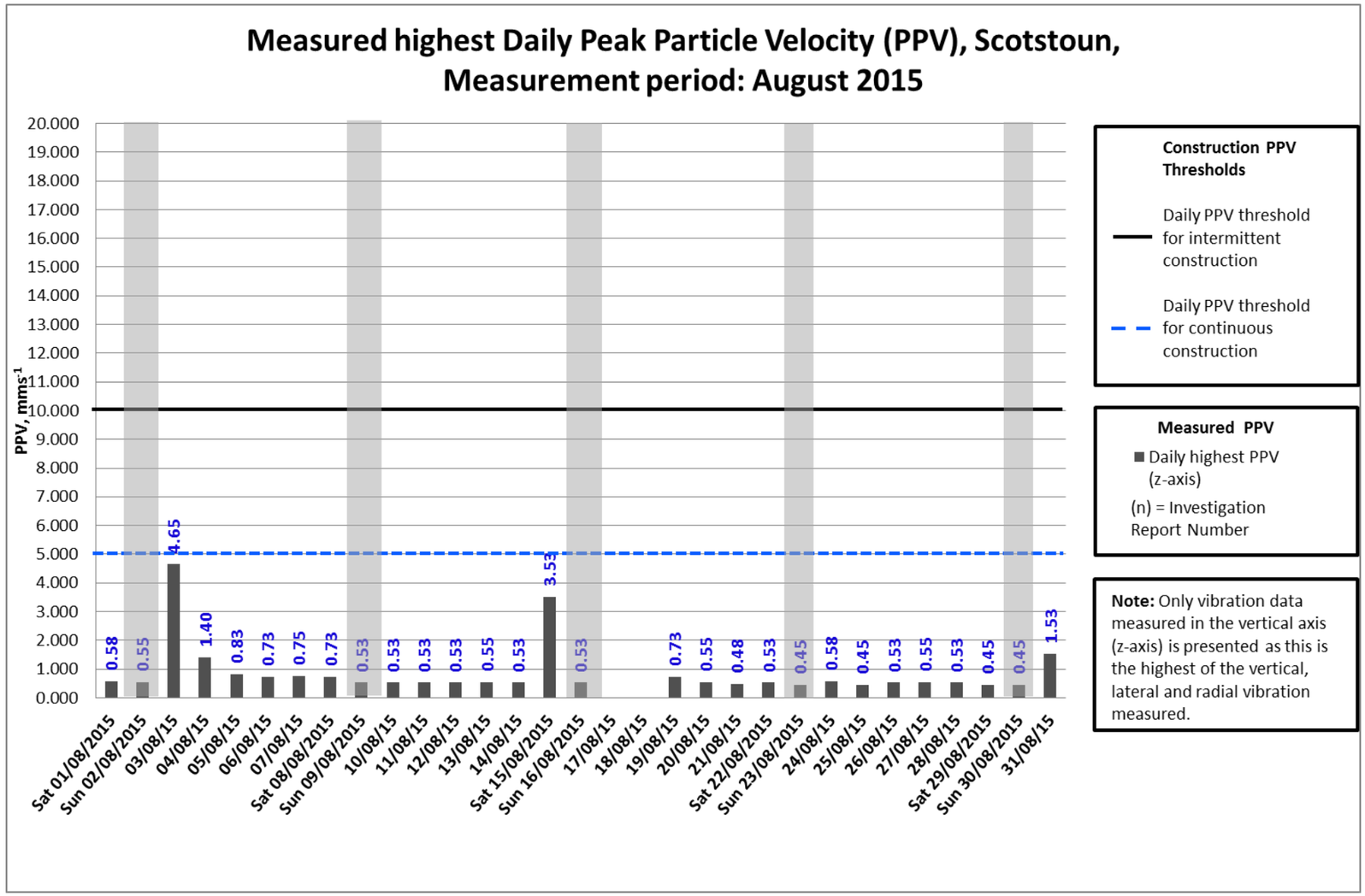




Exceedance on the 11/08/2015 has been investigated and found to be out of construction working hours and is more likely to be caused by movement near by the monitor (graph above). Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.



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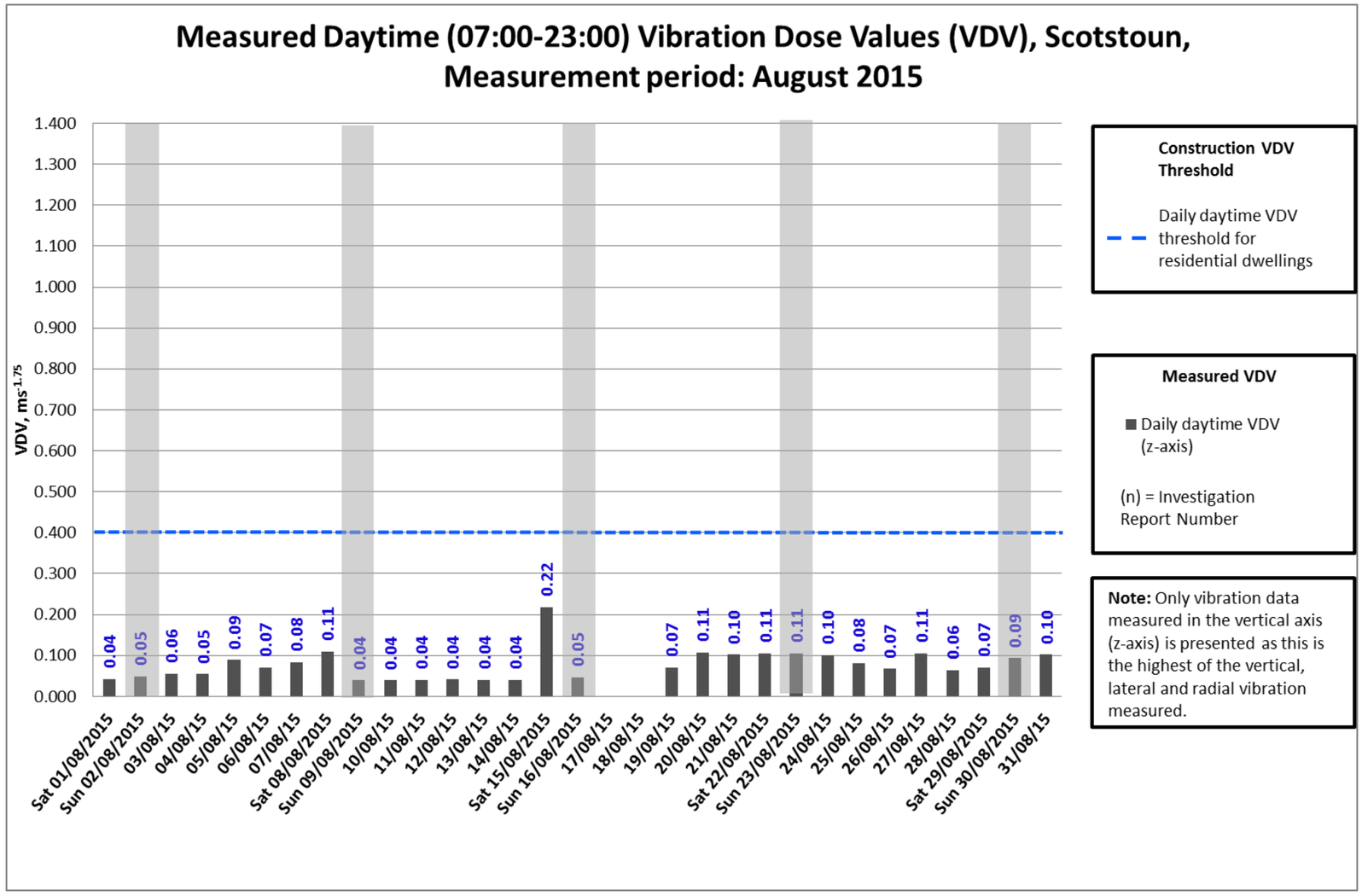
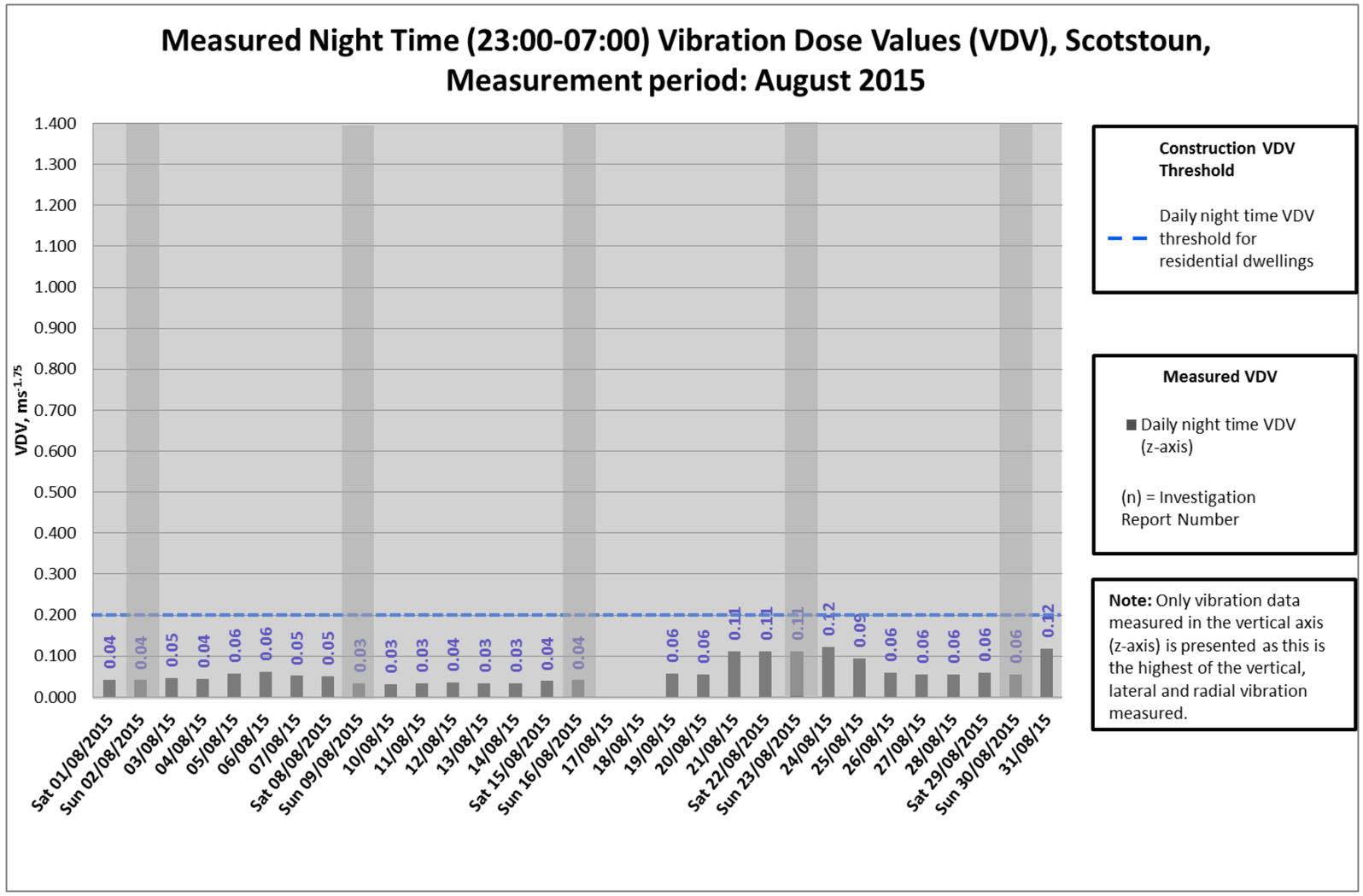
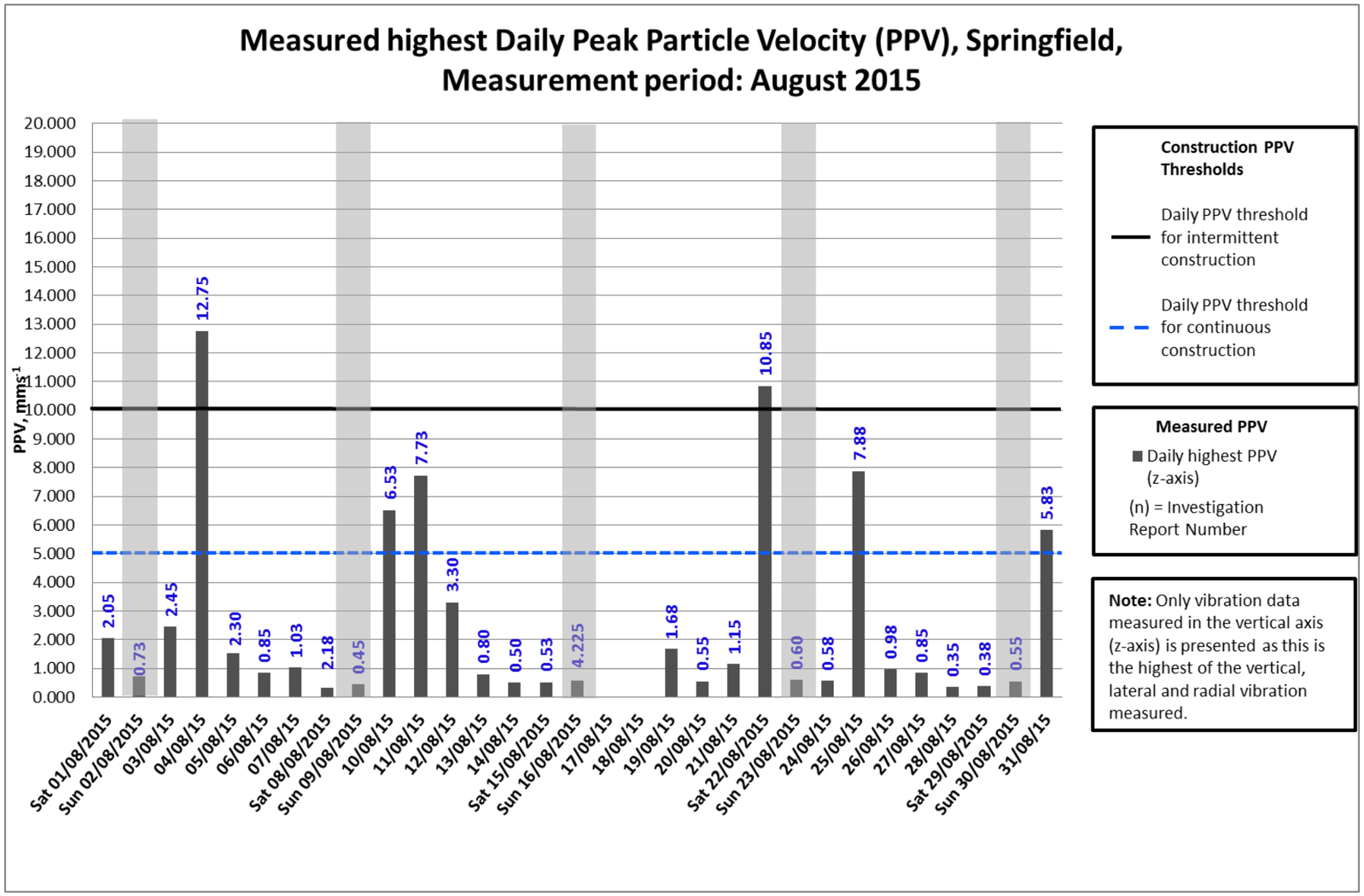
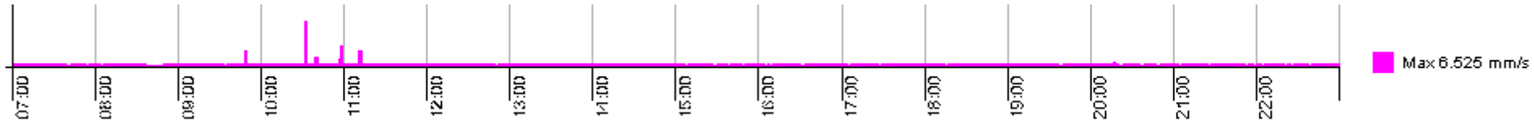


Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.

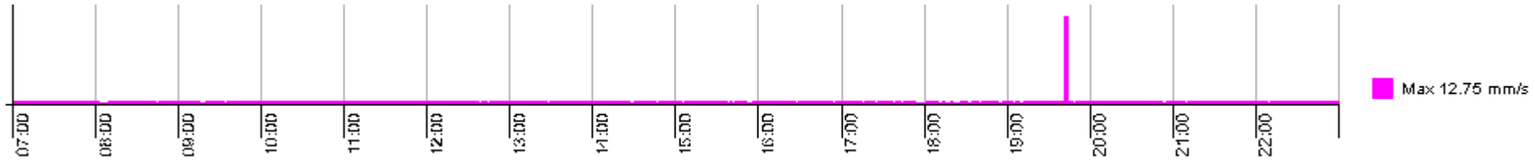


Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.

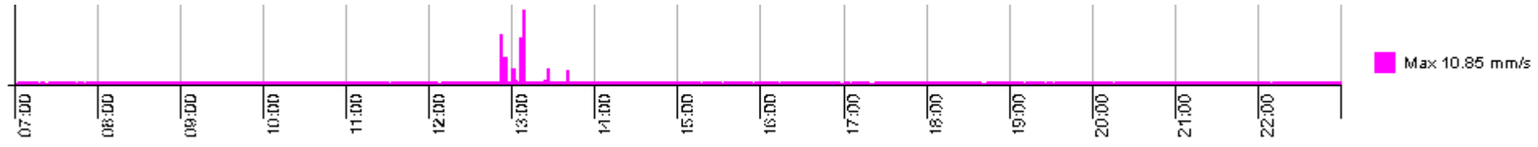

Measured highest Daily Peak Particle Velocity (PPV), Springfield,
Measurement period: August 2015
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
2.05
0.73
2.45
12.75
2.30
0.85
1.03
2.18
0.45
6.53
7.73
3.30
0.80
0.50
0.53
4.225
1.68
0.55
1.15
10.85
0.60
0.58
7.88
0.98
0.85
0.35
0.38
0.55
5.83
Sat 01/08/2015
Sun 02/08/2015
03/08/15
04/08/15
05/08/15
06/08/15
07/08/15
Sat 08/08/2015
Sun 09/08/2015
10/08/15
11/08/15
12/08/15
13/08/15
14/08/15
Sat 15/08/2015
Sun 16/08/2015
17/08/15
18/08/15
19/08/15
20/08/15
21/08/15
Sat 22/08/2015
Sun 23/08/2015
24/08/15
25/08/15
26/08/15
27/08/15
28/08/15
Sat 29/08/2015
Sun 30/08/2015
31/08/15
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
Daily highest PPV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.



Exceedances on the 10/08/2015, 11/08/2015, 25/08/2015 and 31/08/2015 have been investigated and found to be individual isolated events which are unlikely to be construction related. Due to the location of the monitor it is likely to be movement nearby the monitor due to the location being in a residents garden (as seen from the graph above from 10/08/2015).

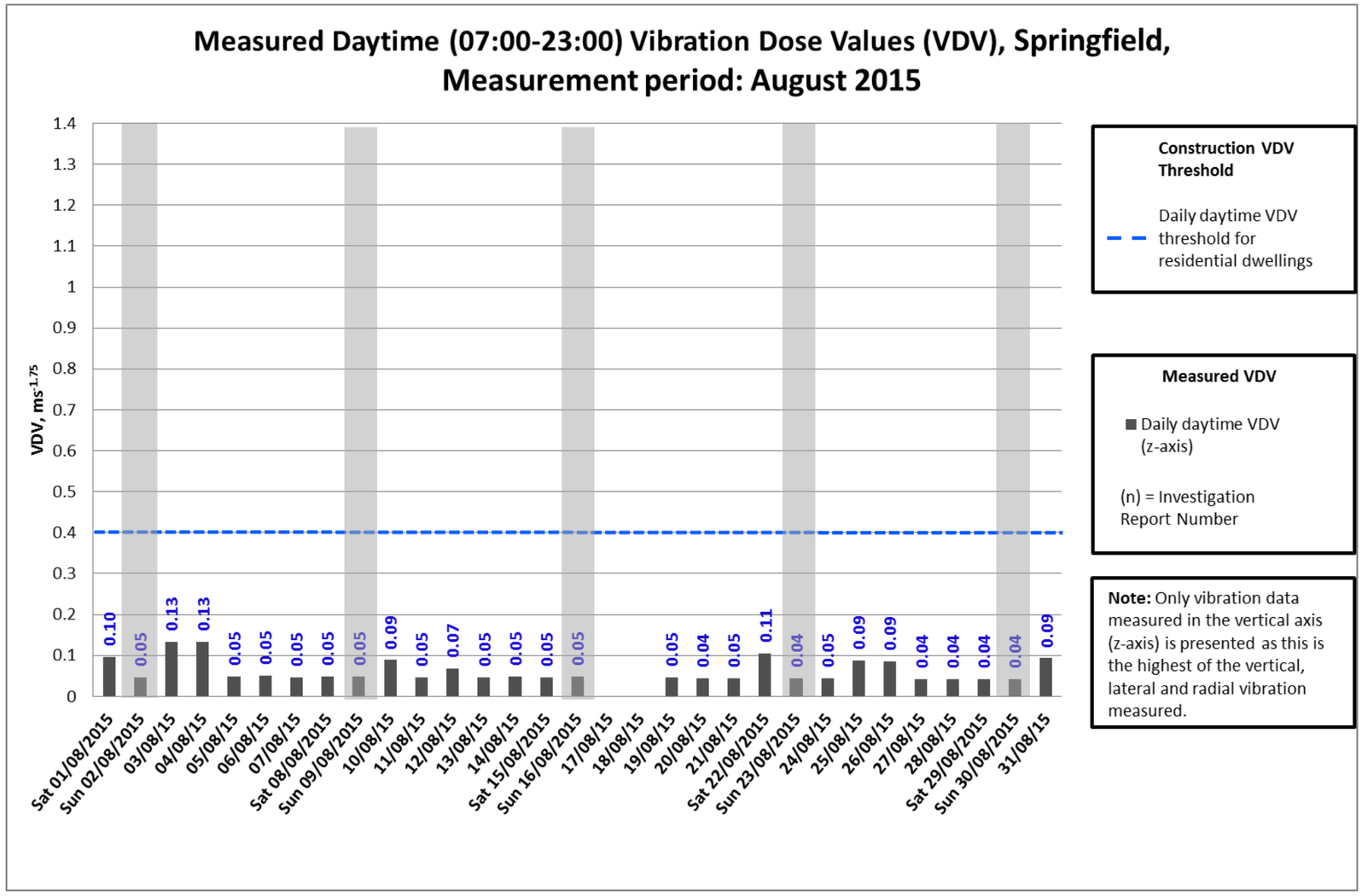


Exceedance on the 04/08/2015 has been investigated and found to be out of construction working hours and highly unlikely to be caused by construction related activities.

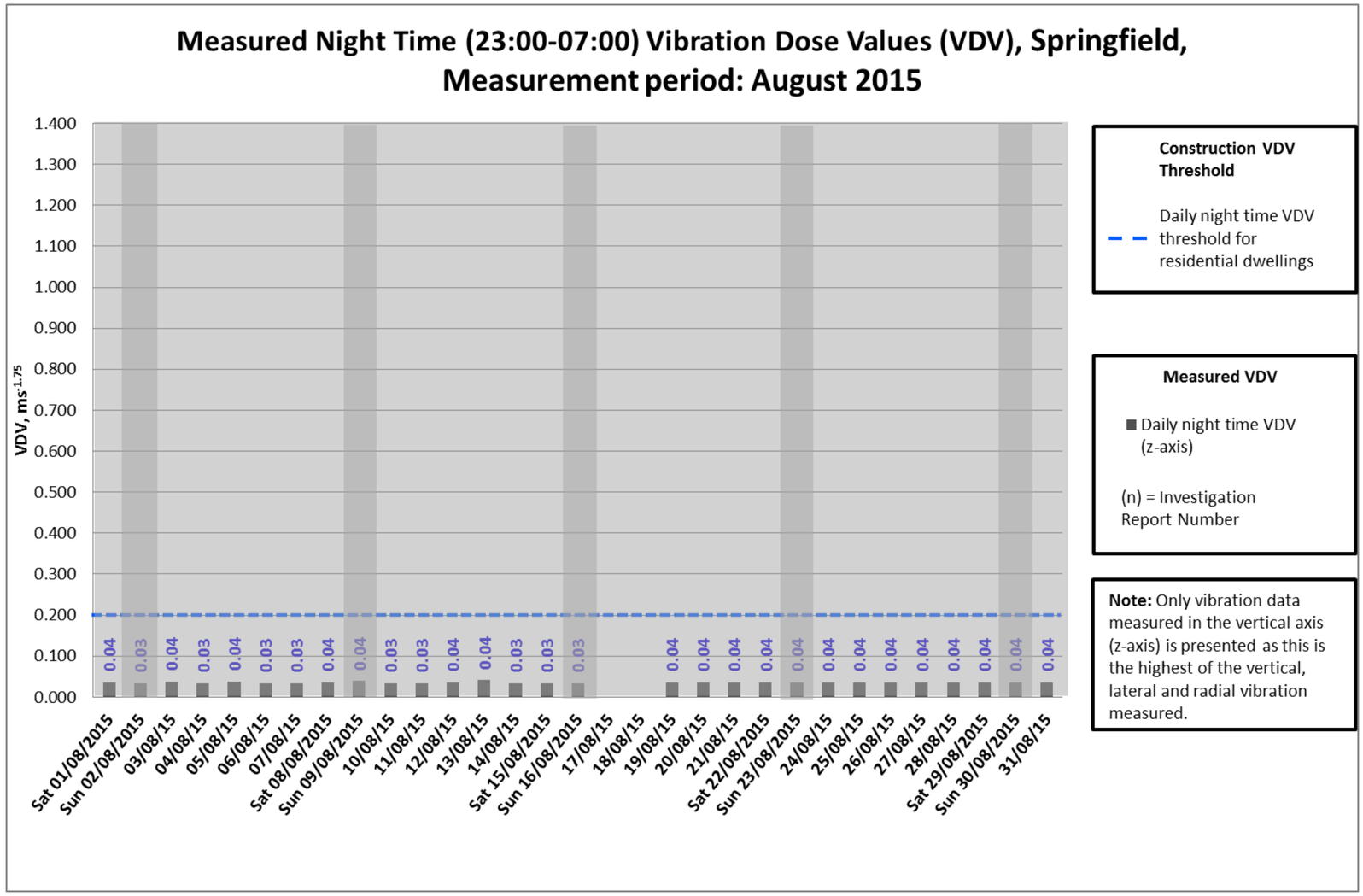


Exceedance on the 22/09/2015 has been investigated and the exceedance is likely to be caused by movement nearby the vibration monitor as residents were heard on the noise monitor at that time.

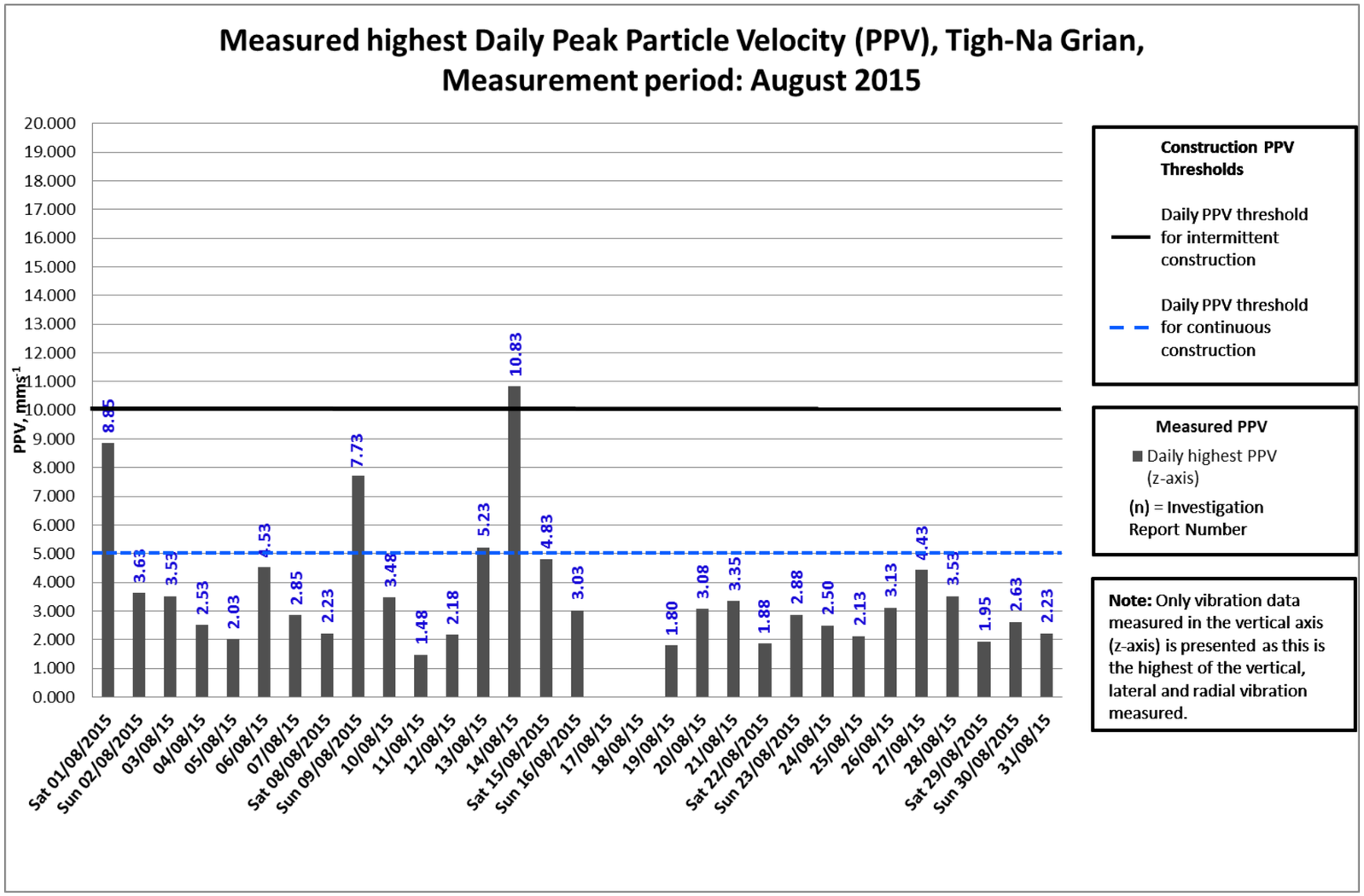
Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.



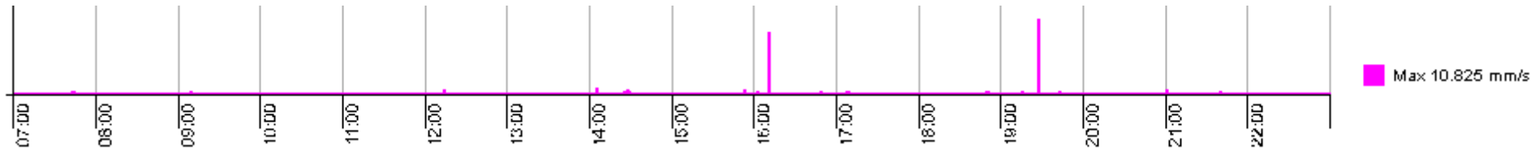
Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.



Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.

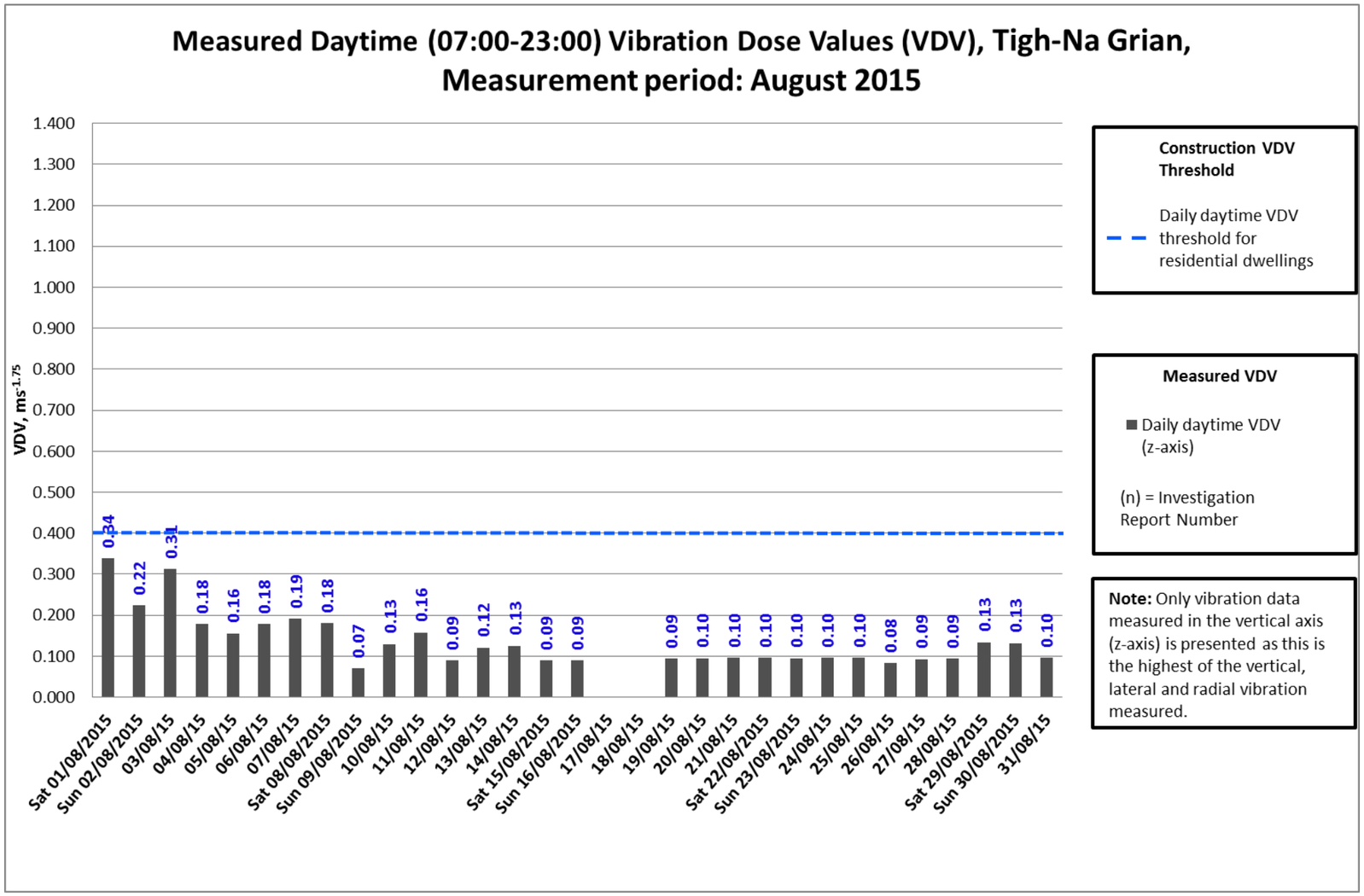

Measured highest Daily Peak Particle Velocity (PPV), Tigh-Na Grian,
Measurement period: August 2015
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
8.85
3.63
3.53
2.53
2.03
4.53
2.85
2.23
7.73
3.48
1.48
2.18
5.23
10.83
4.83
3.03
1.80
3.08
3.35
1.88
2.88
2.50
2.13
3.13
4.43
3.53
1.95
2.63
2.23
Sat 01/08/2015
Sun 02/08/2015
03/08/15
04/08/15
05/08/15
06/08/15
07/08/15
Sat 08/08/2015
Sun 09/08/2015
10/08/15
11/08/15
12/08/15
13/08/15
14/08/15
Sat 15/08/2015
Sun 16/08/2015
17/08/15
18/08/15
19/08/15
20/08/15
21/08/15
Sat 22/08/2015
Sun 23/08/2015
24/08/15
25/08/15
26/08/15
27/08/15
28/08/15
Sat 29/08/2015
Sun 30/08/2015
31/08/15
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
Daily highest PPV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.

Exceedances on the 01/08/2015, 09/08/2015 and on the 13/08/2015 have been investigated (graph above from the 01/08/2015) and all have been found to be isolated events unlikely to be related to construction due to no machinery that can create high vibration within 400 metres of the vibration monitor.

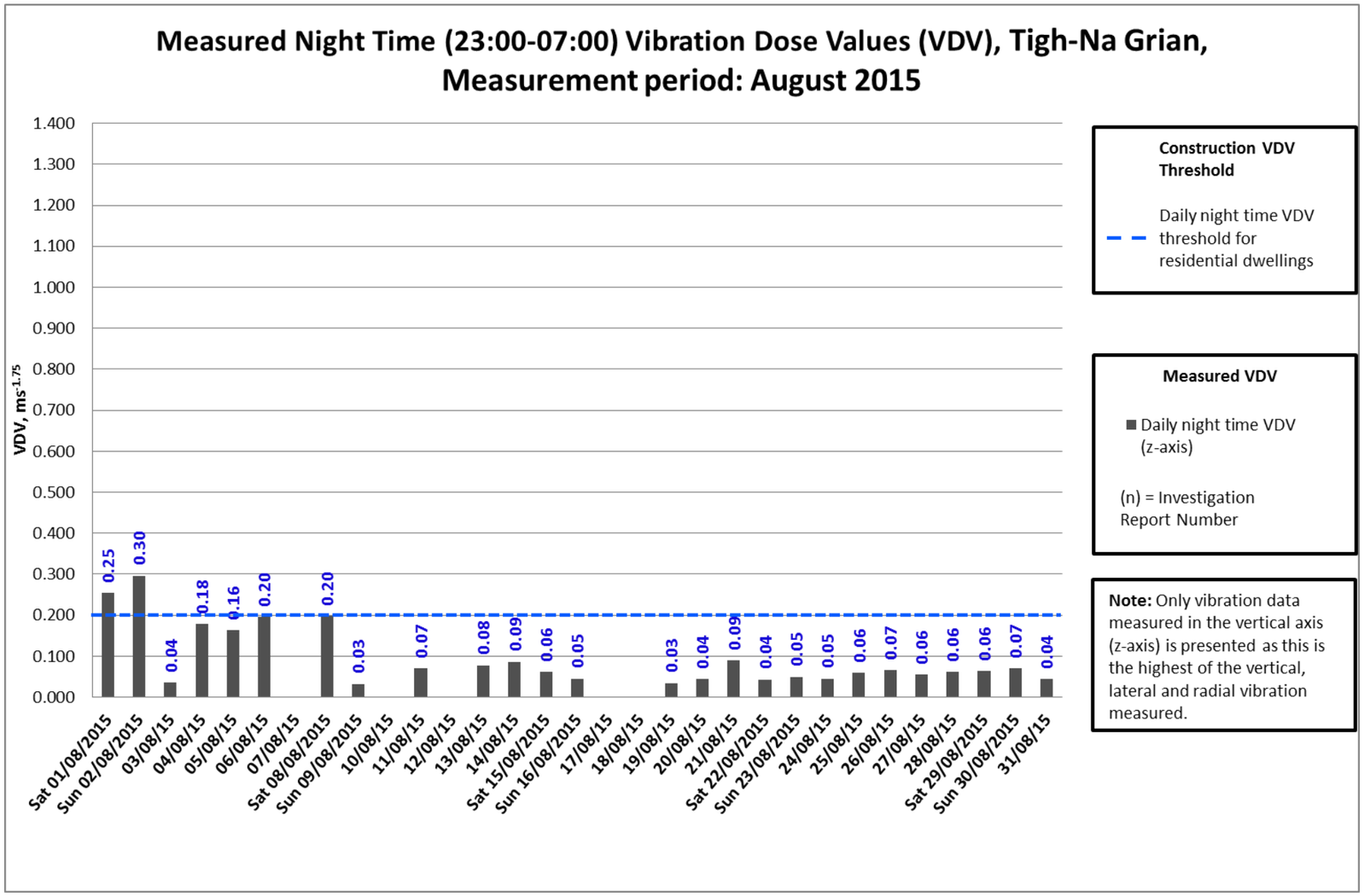


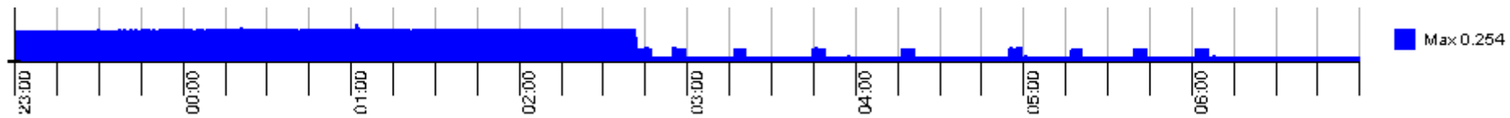
Exceedance on the 14/08/2015 has been investigated and found to be an isolated event which is unlikely to be construction related due to the high level of the exceedance and due to the distance between the closest works and the monitor (250 meters away).

Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.



Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.

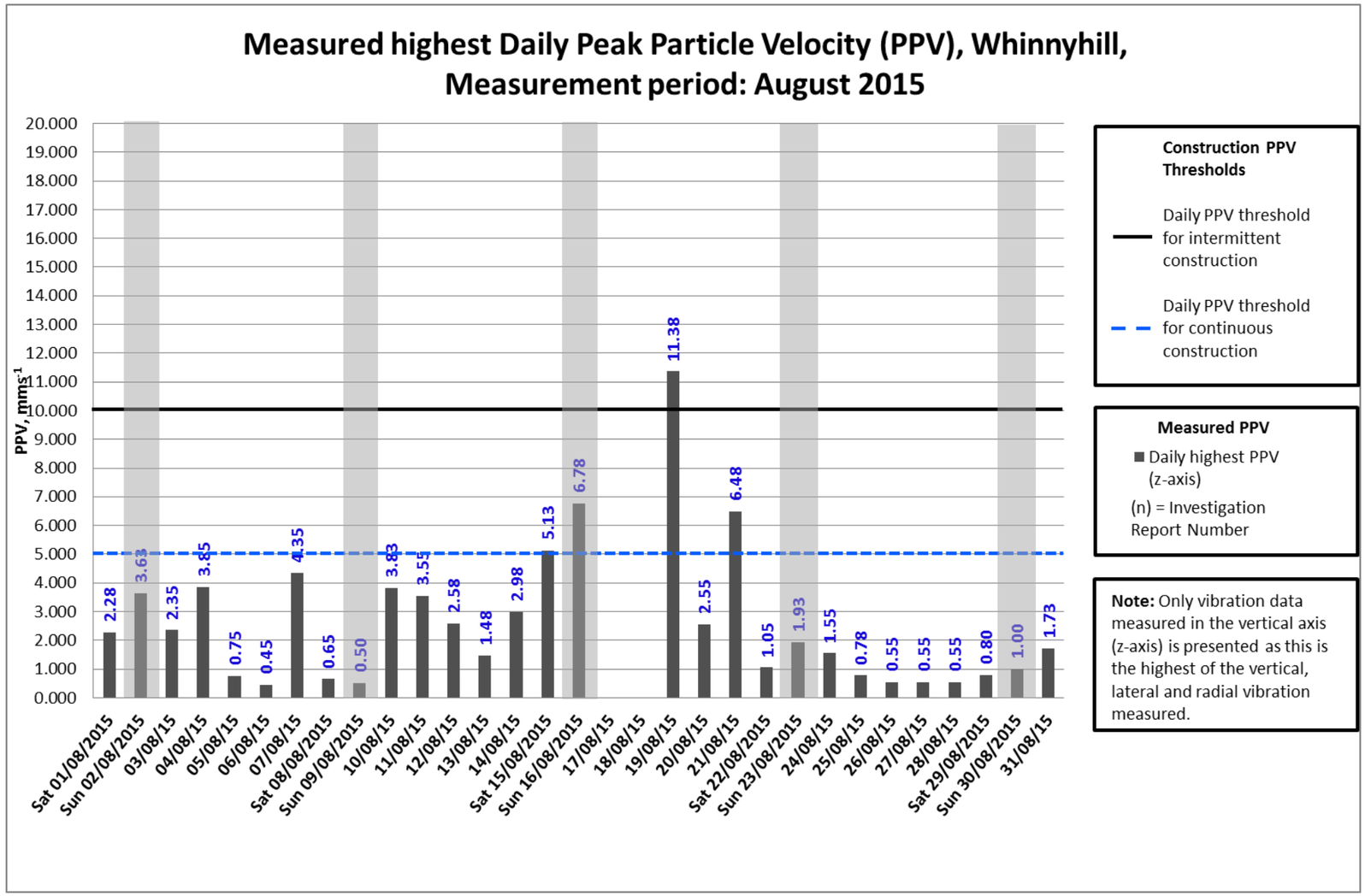

Measured Night Time (23:00-07:00) Vibration Dose Values (VDV), Tigh-Na Grian, Measurement period: August 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.25
0.30
0.04
0.18
0.16
0.20
0.20
0.03
0.07
0.08
0.09
0.06
0.05
0.03
0.04
0.09
0.04
0.05
0.05
0.06
0.07
0.06
0.06
0.06
0.07
0.04
Sat 01/08/2015
Sun 02/08/2015
03/08/15
04/08/15
05/08/15
06/08/15
07/08/15
Sat 08/08/2015
Sun 09/08/2015
10/08/15
11/08/15
12/08/15
13/08/15
14/08/15
Sat 15/08/2015
Sun 16/08/2015
17/08/15
18/08/15
19/08/15
20/08/15
21/08/15
Sat 22/08/2015
Sun 23/08/2015
24/08/15
25/08/15
26/08/15
27/08/15
28/08/15
Sat 29/08/2015
Sun 30/08/2015
31/08/15
Construction VDV Threshold
Daily night time VDV threshold for residential dwellings
Measured VDV
Daily night time VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.

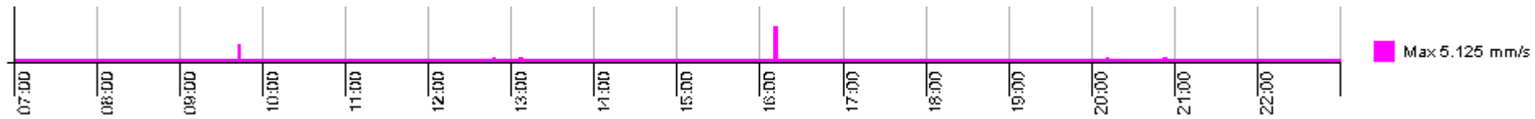


Exceedances on the 01/08/2015 and on the 02/08/2015 have been investigated and found to be the continued trend from last month that has been investigated and found not to be construction related, the investigation from last month states- "Investigations into the vibration exceedances that started on the 25/07/2015 to the 31/07/2015 (trend starts on the 15/07/2015) have proved inconclusive. However it is noted that the vibration is constant during day and night periods. All construction work within a 300 meter radius of the monitor has been investigated and found not to be using any vibration inducing equipment. The noise monitor at this location during similar times shows no matching trend or noise exceedances related to construction".

Exceedances on the 06/08/2015 and on the 08/08/2015 have been investigated and found not to be exceedances due to the graph rounding up to 2 decimal places, the actual figures are as follows 06/08/2015 was 0.196 and on the 08/08/2015 was 0.198.

Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.
Missing data on the 07/08/2015, 10/08/2015 and 12/08/2015 was due to corrupt data on the vibration monitor

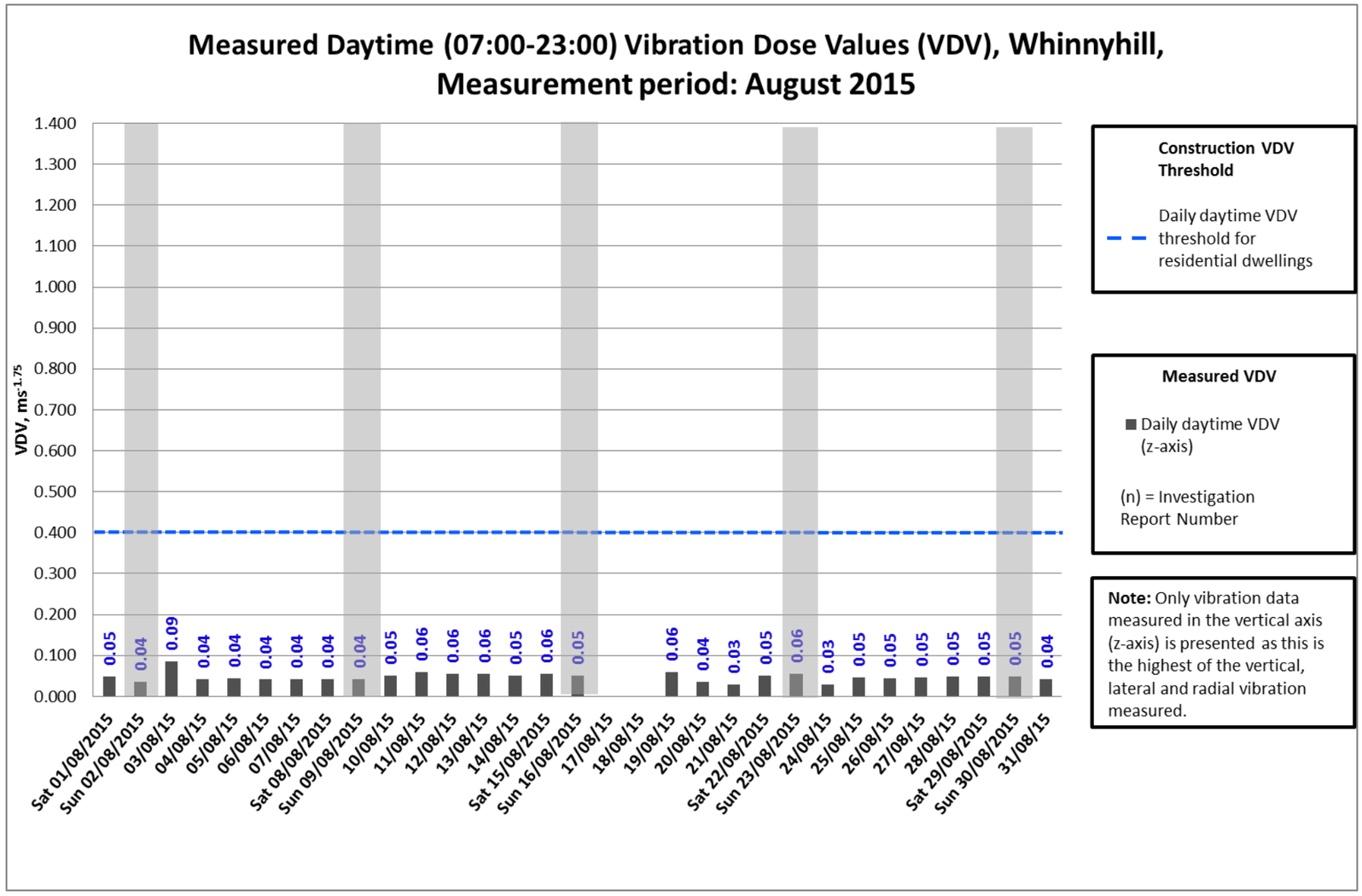

Measured highest Daily Peak Particle Velocity (PPV), Whinnyhill,
Measurement period: August 2015
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
2.28
3.63
2.35
3.85
0.75
0.45
4.35
0.65
0.50
3.83
3.55
2.58
1.48
2.98
5.13
6.78
11.38
6.48
2.55
1.05
1.93
1.55
0.78
0.55
0.55
0.55
0.80
1.00
1.73
Sat 01/08/2015
Sun 02/08/2015
03/08/15
04/08/15
05/08/15
06/08/15
07/08/15
Sat 08/08/2015
Sun 09/08/2015
10/08/15
11/08/15
12/08/15
13/08/15
14/08/15
Sat 15/08/2015
Sun 16/08/2015
17/08/15
18/08/15
19/08/15
20/08/15
21/08/15
Sat 22/08/2015
Sun 23/08/2015
24/08/15
25/08/15
26/08/15
27/08/15
28/08/15
Sat 29/08/2015
Sun 30/08/2015
31/08/15
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
Daily highest PPV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.



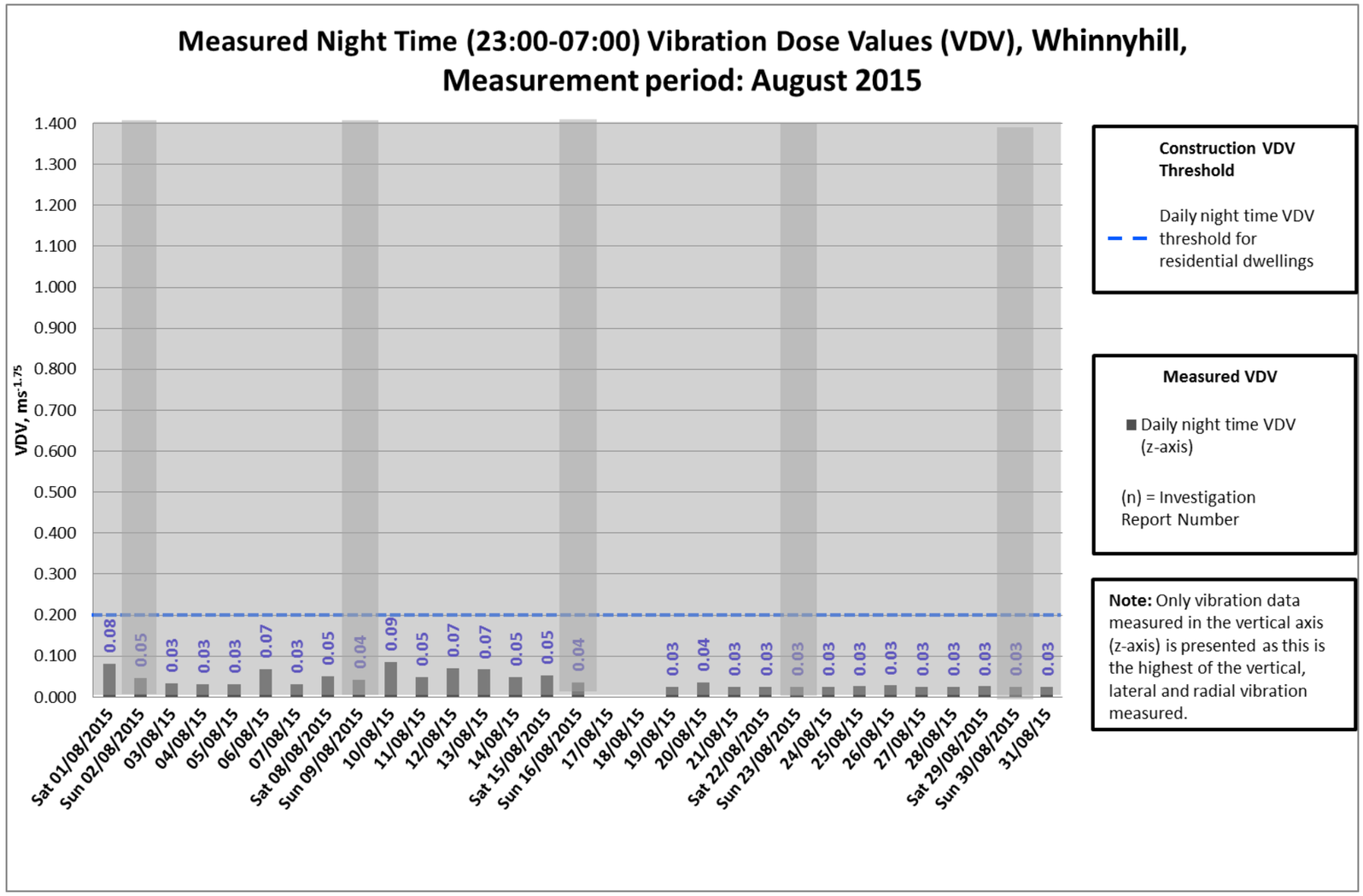
Exceedances on the 15/08/2015, 16/08/2015 and on the 21/08/2015 have been investigated and found to be isolated events unlikely to be related to construction activities due to the distance away from the works (120 meters away) (graph above from the 15/08/2015).

Exceedance on the 19/08/2015 has been investigated and found to be and isolated event that is unlikely to be construction related due to the distance away from the works (120 meters away).

Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.



Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.



Missing data on the 17/08/2015 to the 18/08/2015 was due to the vibration monitor getting its yearly calibration.