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# Review of reports on vibration caused by heavy machinery (LBNL)

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# Reports on vibration caused by heavy machinery (LBNL – ALS)

- "Building 51 Demolition Vibration Study" [12 May 2006]
- "LBNL Building 10 Demolition Vibration Test" [7 Sep 2006]

→ 0.1 µm

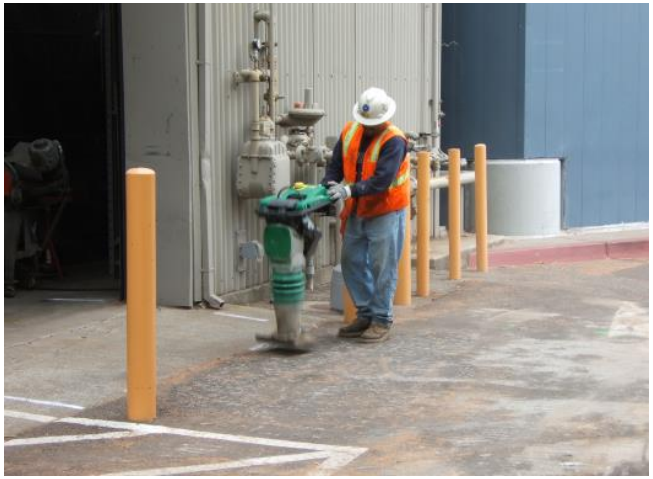
- "SERC Paving (Vibration Measurement Results)" [19 Nov 2014]

→ 15-20 nm

WILSON, IHRIG & ASSOCIATES, INC.
ACOUSTICAL CONSULTANTS

# Heavy Machinery (Bld. 10 Demolition)

Excavator

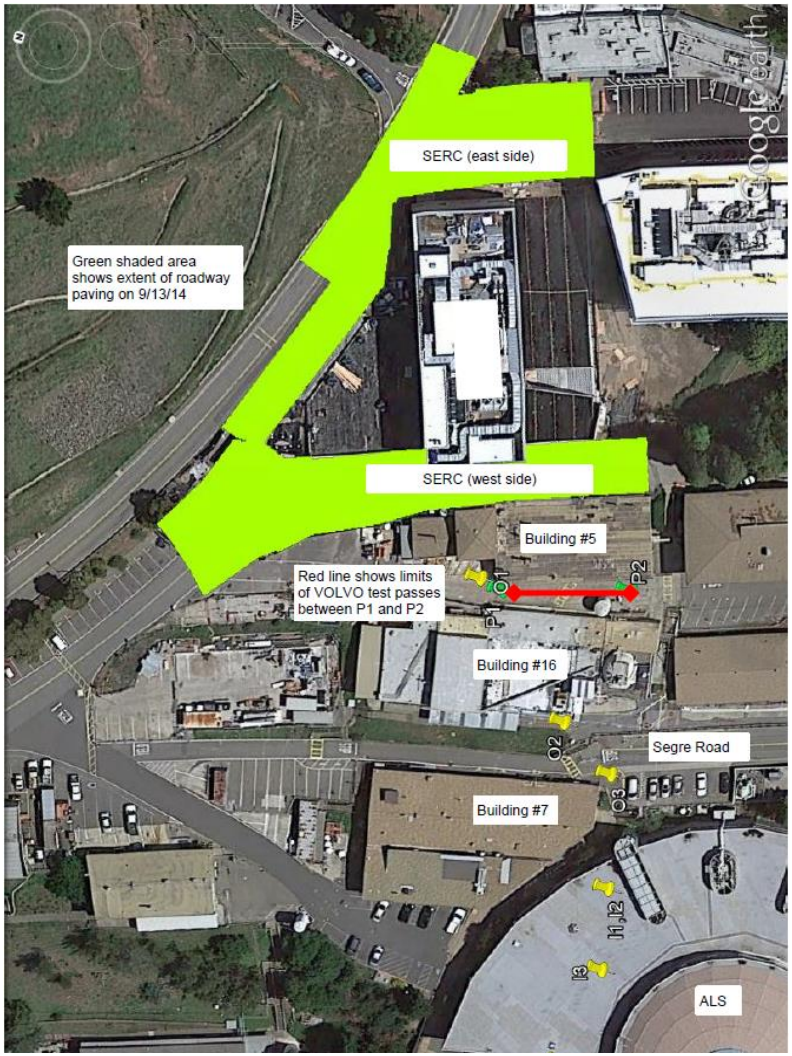


Jumping Jack

Concrete Saw

Hoe Ram

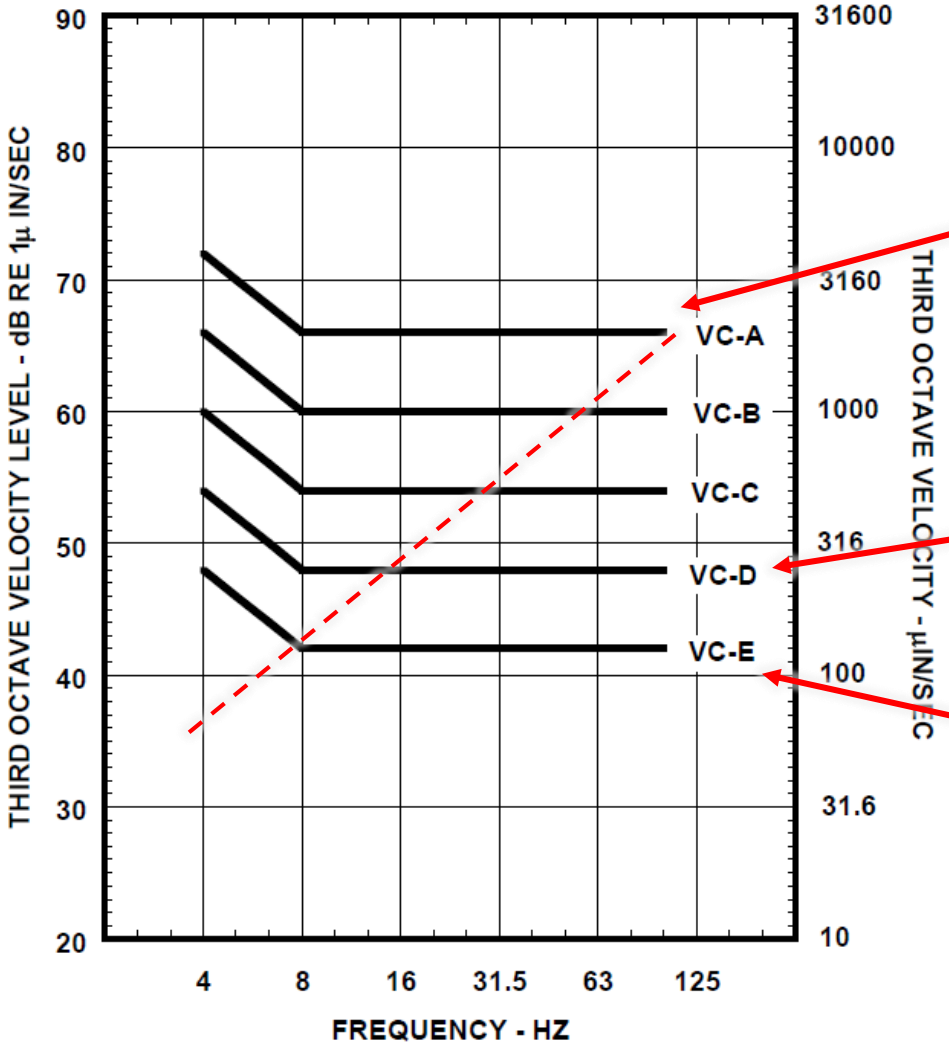
# Vibration Rollers and Measurement Setup (SERC Paving)

# IES Criteria for Vibration

| Criterion | Level Decibels re 1micro-in/sec | Amplitude micro-in/sec | Amplitude micron/sec | Detail Size micron | Description of Use |
|---|---|---|---|---|---|
| VC-A | 66 | 2000 | 50 | 8 | Adequate for optical microscopes to 400x, microbalances, optical balances, proximity and projection aligners |
| VC-B | 60 | 1000 | 25 | 3 | Optical microscopes to 1000x, inspection and lithography equipment to 3micron line widths |
| VC-C | 54 | 500 | 12.5 | 1 | Most lithography and inspection equipment, including electron microscopes, to 1micron size |
| VC-D | 48 | 250 | 6.2 | 0.3 | Suitable in most instances for the most demanding of equipment, including electron microscopes, transmission electron microscopes, and electron-beam systems, operating to the limits of their capacity |
| VC-E | 42 | 125 | 3.1 | 0.1 | Assumed to be adequate for the most demanding of sensitive systems, including long path, laser based, small target systems, and other systems requiring extraordinary dynamic stability |
| VC-F | 36 | 63 | 1.6 | 0.03 | A descriptive curve for characterizing very low vibration environments |

# VC Curves



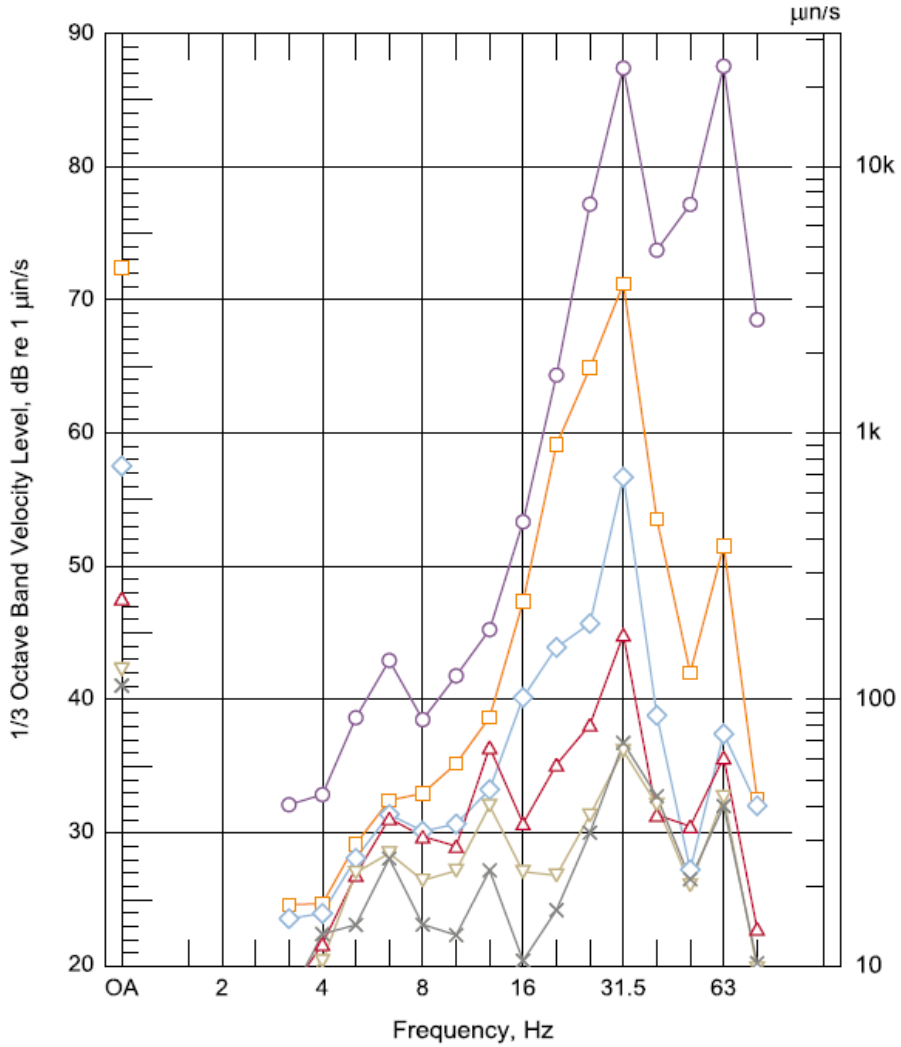

Ground Vibration

**0.1 µm**

6.3 µm/s (~250 µin/s)
@ 10 Hz

3 µm/s (~125 µin/s)
@ 5 Hz

# VOLVO DD25W (HK5V83) at P1 vs Distance

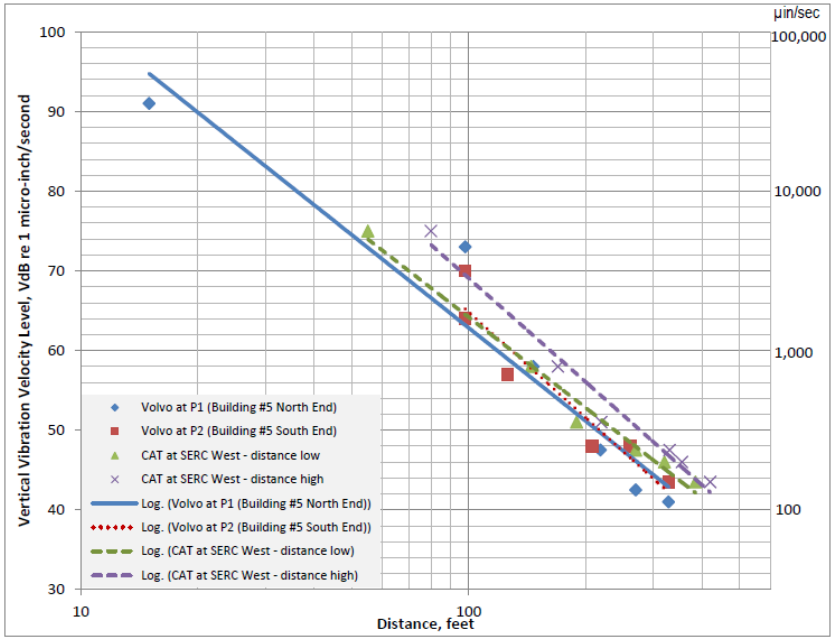




E Avg. of Lmax - Volvo DD25W - P1 - O1 - 15 ft
E Avg. of Lmax - Volvo DD25W - P1 - O2 - 98 ft
E Avg. of Lmax - Volvo DD25W - P1 - O3 - 147 ft
E Avg. of Lmax - Volvo DD25W - P1 - I1 - 219 ft
E Avg. of Lmax - Volvo DD25W - P1 - I3 - 270 ft
E Avg. of Lmax - Volvo DD25W - P1 - I4 - 328 ft

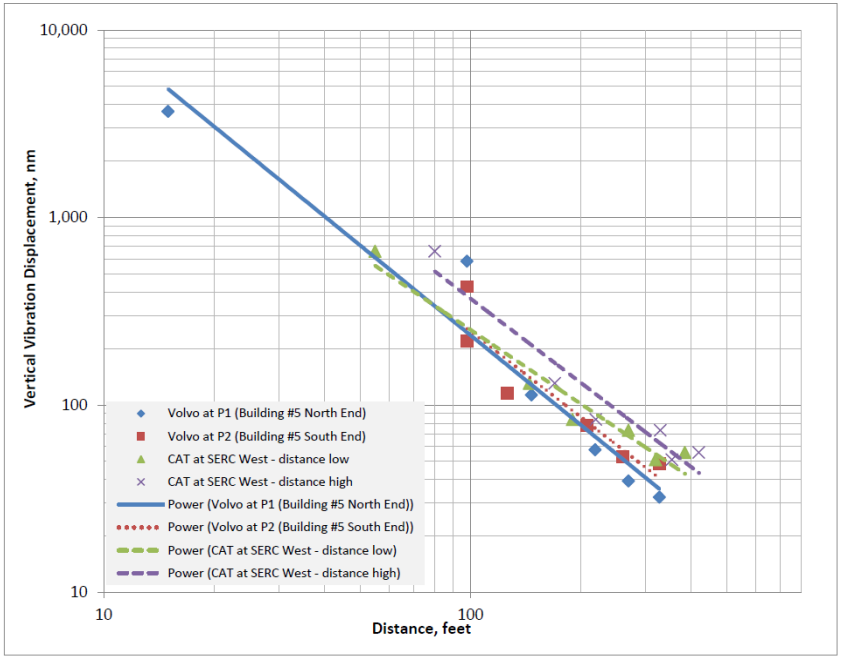
IMPORTANT:
Integration time – 1s

# Overall Velocity/Displacement vs Distance

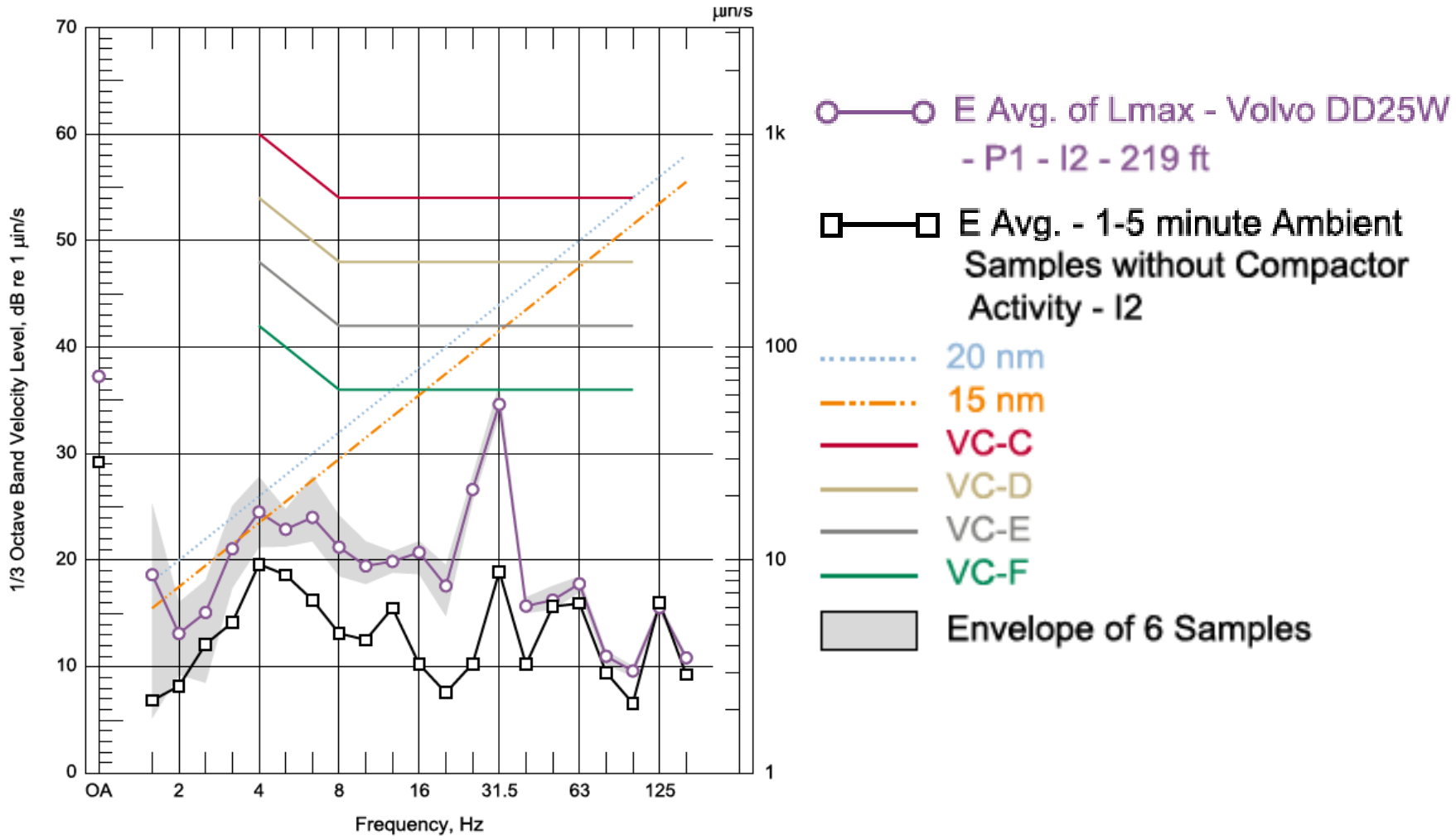



Velocity vs Distance

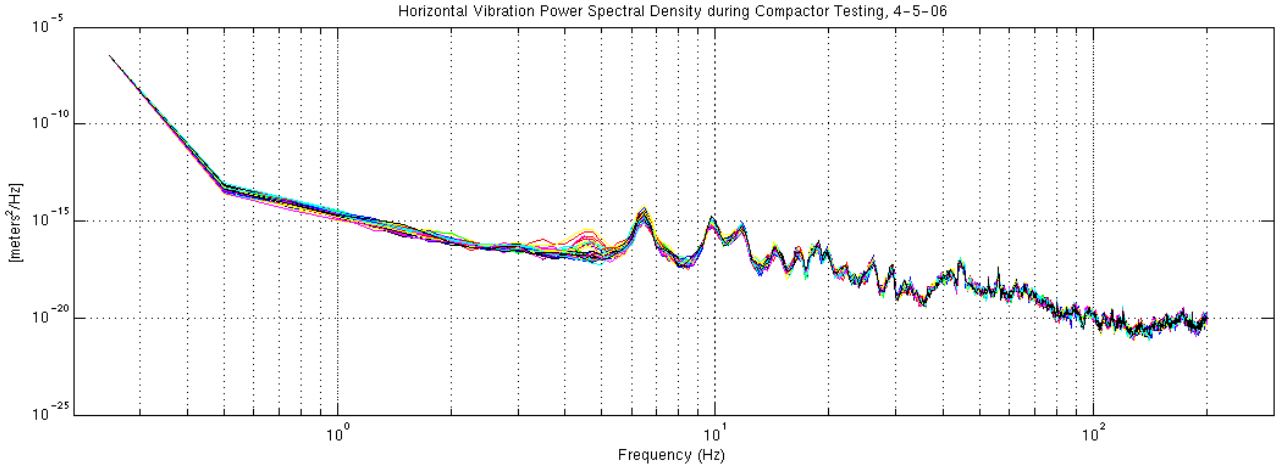
Displacement vs Distance

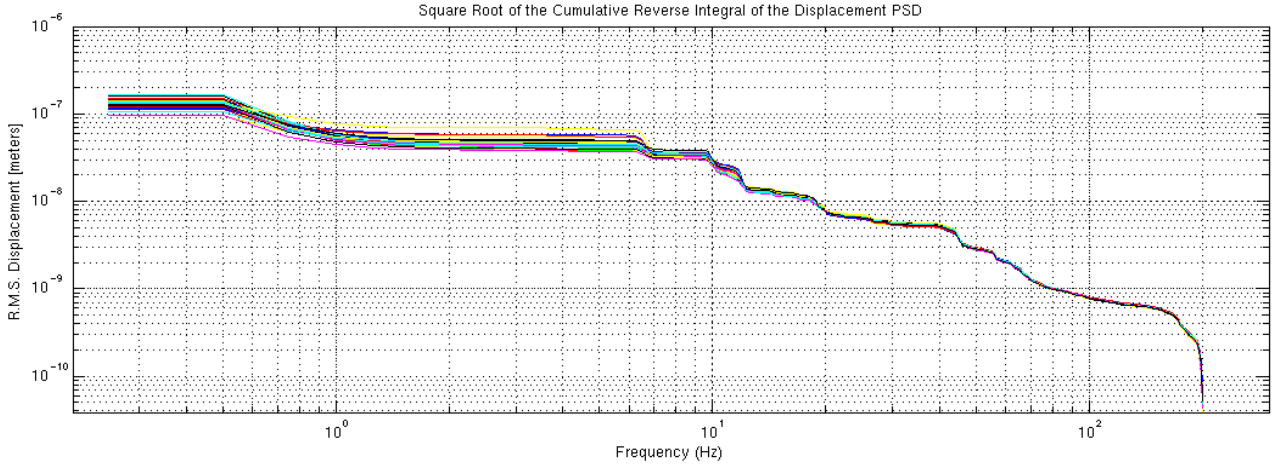


# 3rd Octave Band Velocity, loc. I2 (example)



# Power Spectral Density & IRMS (BLD51-ALS)



# Which of these can be of use to us?

1. 3rd Octave Band Velocities
   - comparison with the VC-Curves, but more important with the constant displacement line
   - give a rough estimate of velocity/displacement value within separate 3rd octave frequency ranges

2. PSD & IRMS
   - give a global integrated value of vibrations for the whole frequency range (overall level of vibrations)

However: in our case for these calculations, we need to know the Transfer Functions and the input PSD from the machinery

# General Conclusions

1. In six reports about the topic, general calculations are performed in 3rd octave band
2. All of these reports are performed for surface infrastructure
3. The requirement for ALS are around 20nm (ground) – comparing to 1 μm for HiLumi (beam)
4. Depending how the velocities are calculated from measured accelerations, we can get different values.