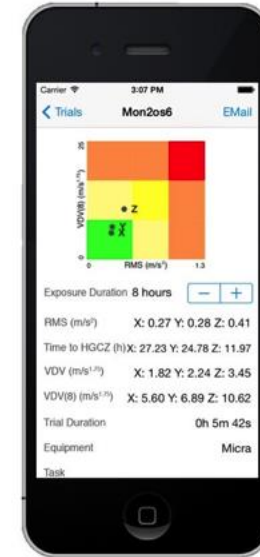


## Measuring whole-body vibration at surface and underground coal mines

**Robin Burgess-Limerick & Danellie Lynas**  
Minerals Industry Safety and Health Centre  
Sustainable Minerals Institute  
The University of Queensland

**SMI MISHC**  
Minerals Industry Safety  
& Health Centre

Leading Risk, Health  
and Safety Management  
for the minerals  
industry



Health & Safety Trust



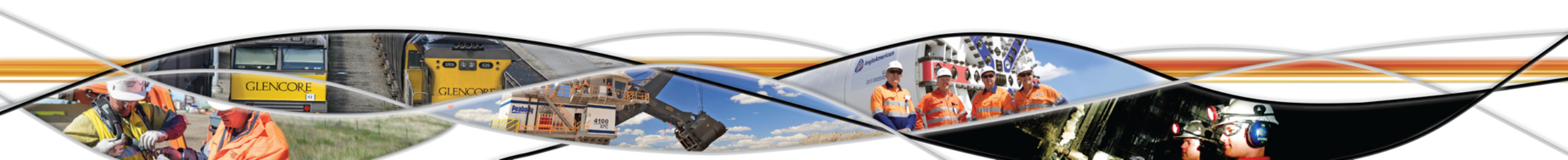
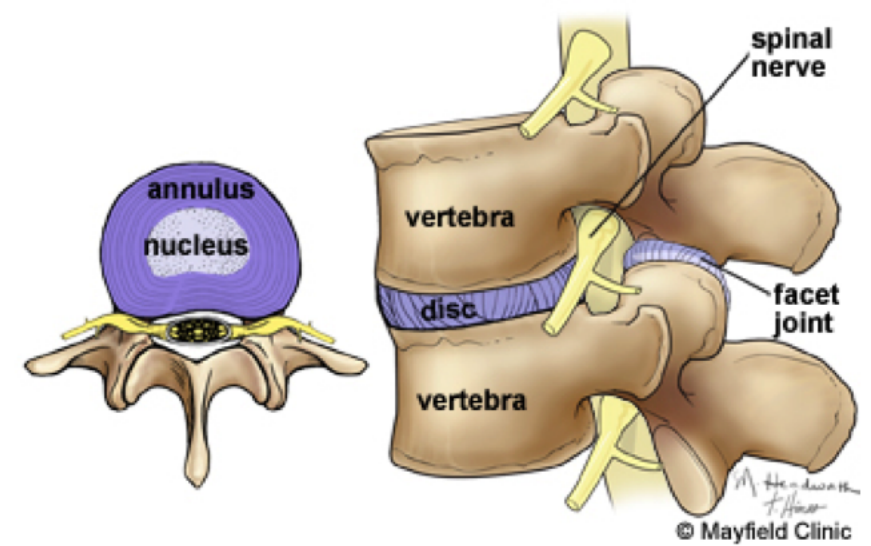


*A Past forgotten is a future repeated*

Long term exposure to whole body vibration causes serious health effects, particularly back pain.

Vertebral endplate damage => reduced intervertebral disc nutrition

Most sensitive to 2-10 Hz vibrations





*A Past forgotten is a future repeated*

# Vibration amplitude expressed in terms of frequency weighted accelerations

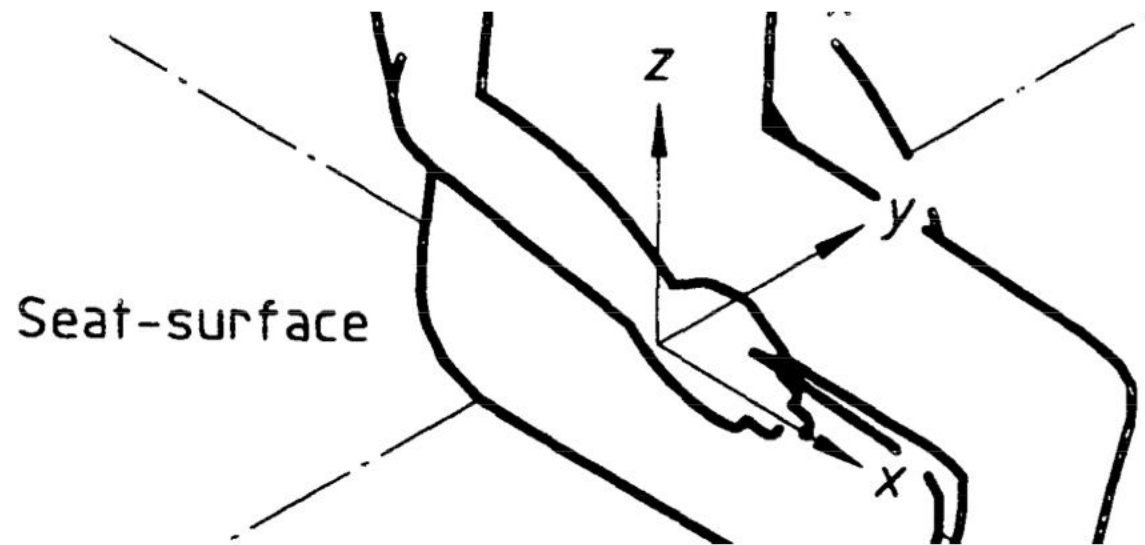
AS 2670.1 / ISO 2631.1

Australian Standard™

**Evaluation of human exposure to whole-body vibration**

**Part 1: General requirements**

[ISO title: Mechanical vibration and shock—Evaluation of human exposure to whole-body vibration, Part 1 General requirements]





*A Past forgotten is a future repeated*

## Two primary measures of vibration amplitude

root mean squared amplitude (r.m.s) m/s<sup>2</sup>  $a_w = \left[ \frac{1}{T} \int_0^T a_w^2(t) dt \right]^{\frac{1}{2}}$

Vibration Dose Value (**VDV**) m/s<sup>1.75</sup>  $VDV = \left\{ \int_0^T [a_w(t)]^4 dt \right\}^{\frac{1}{4}}$

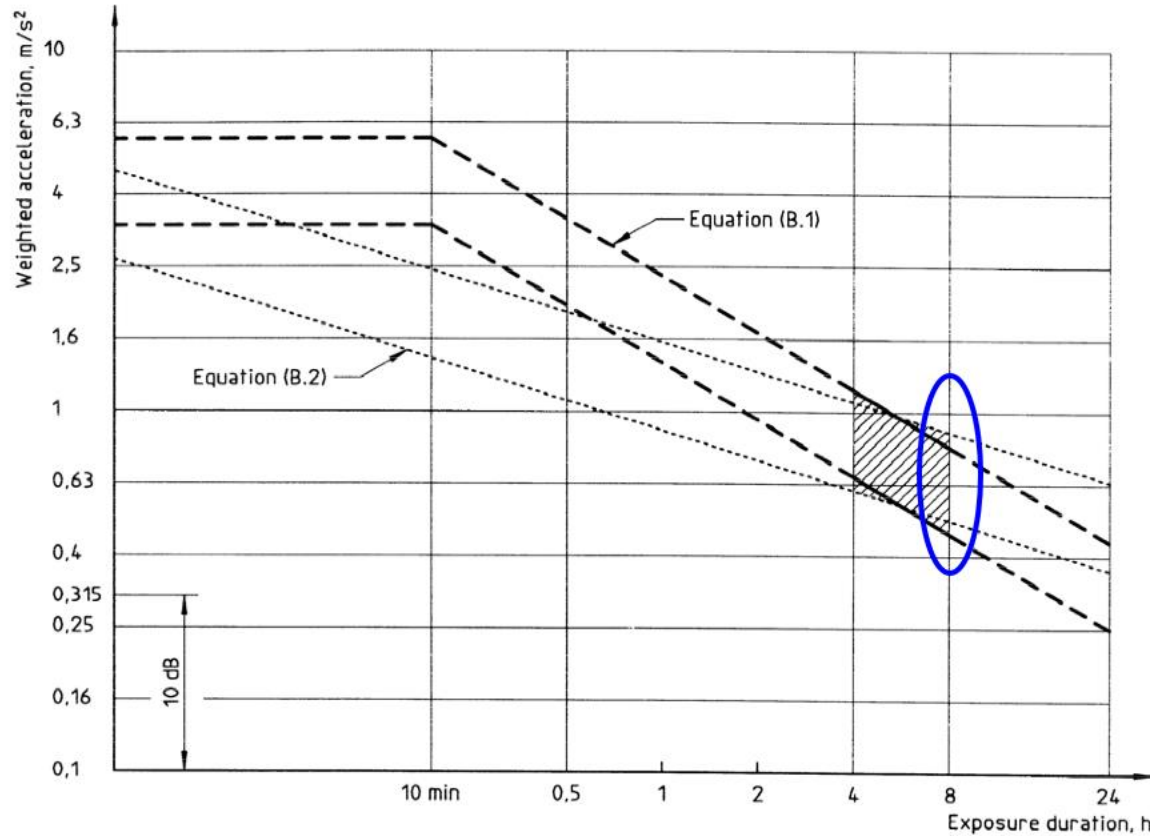
## VDV more sensitive to high amplitude jolts & jars





*A Past forgotten is a Future repeated*

# AS2670.1 / ISO 2631.1 Health Guidance Caution Zone



0.93  $m/s^2$   
0.47  $m/s^2$

For exposures below the zone, health effects have not been clearly documented and/or objectively observed; in the zone, caution with respect to potential health risks is indicated and above the zone health risks are likely.





*A Past forgotten is a Future repeated*

Measurement previously required expensive, fragile, and relatively complex equipment.

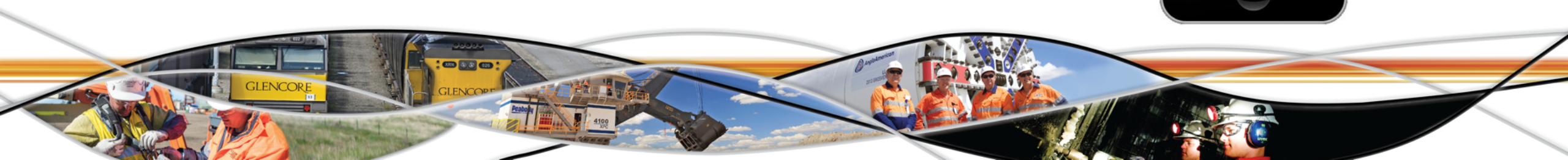
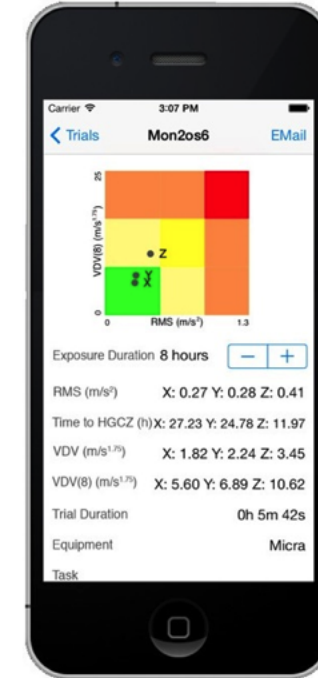


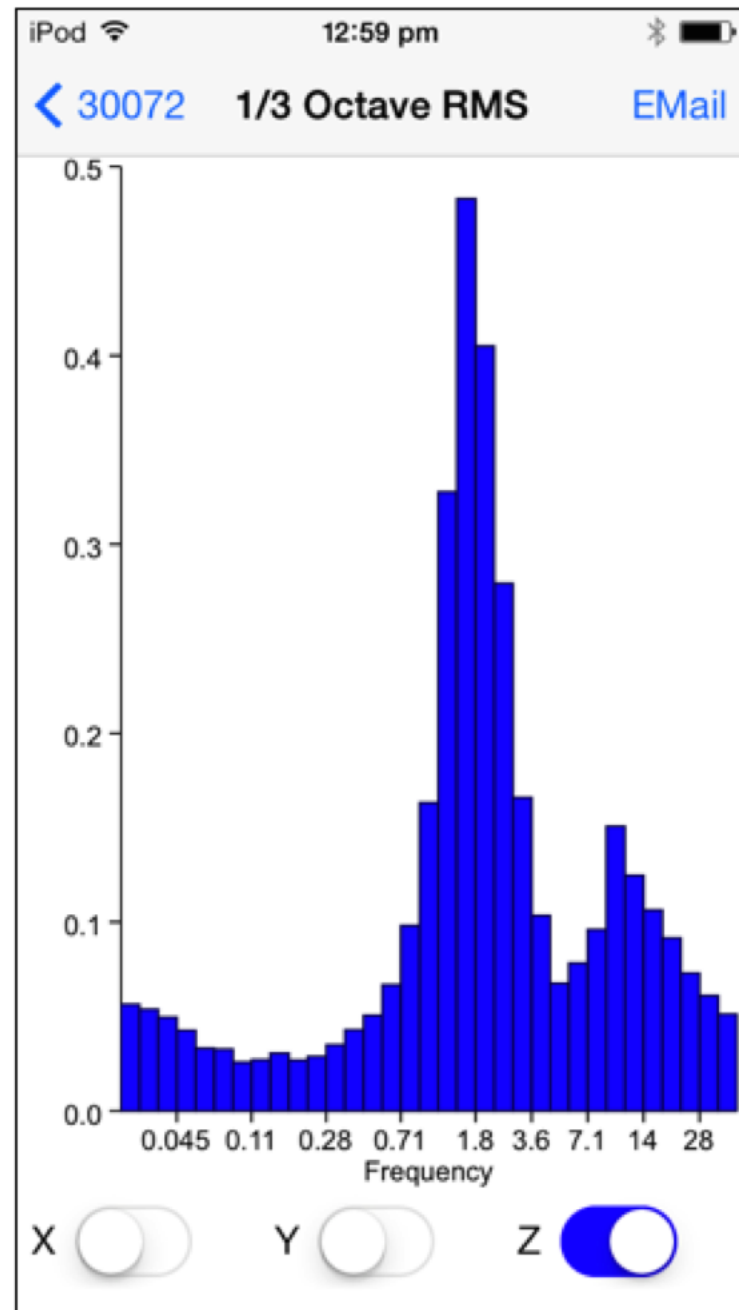
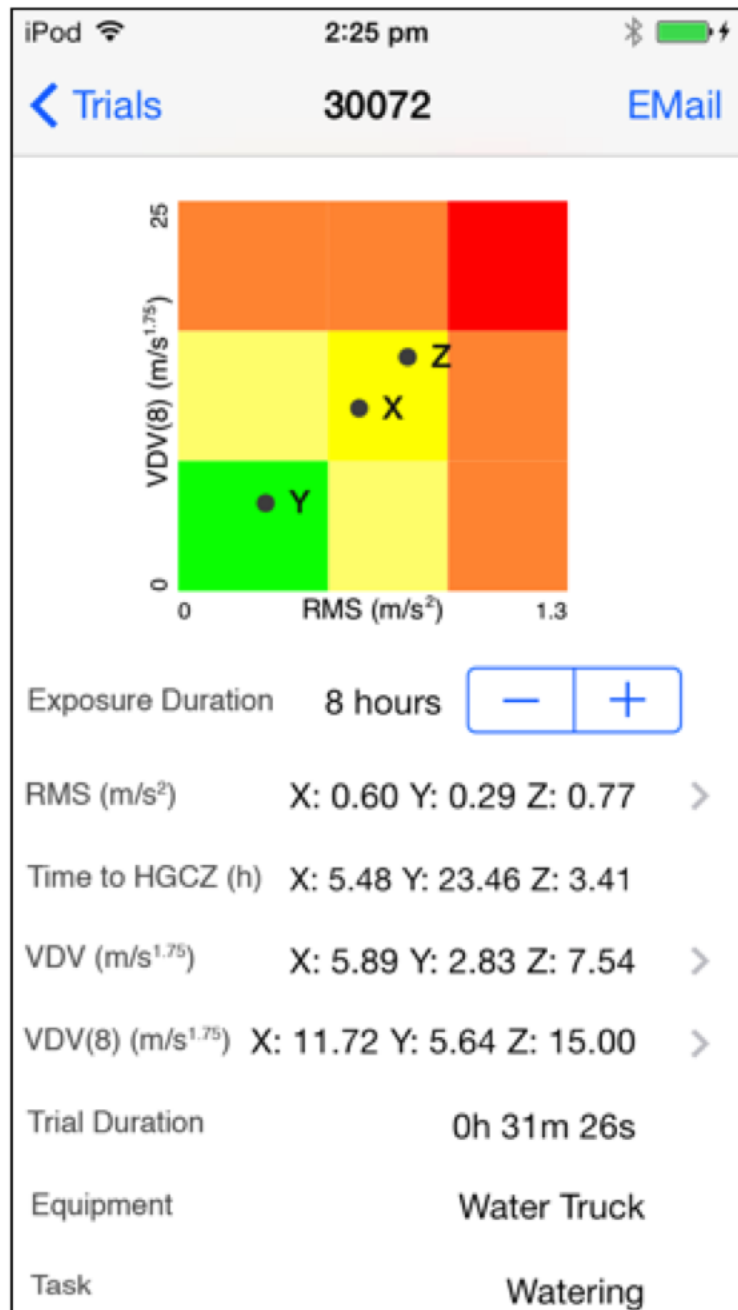
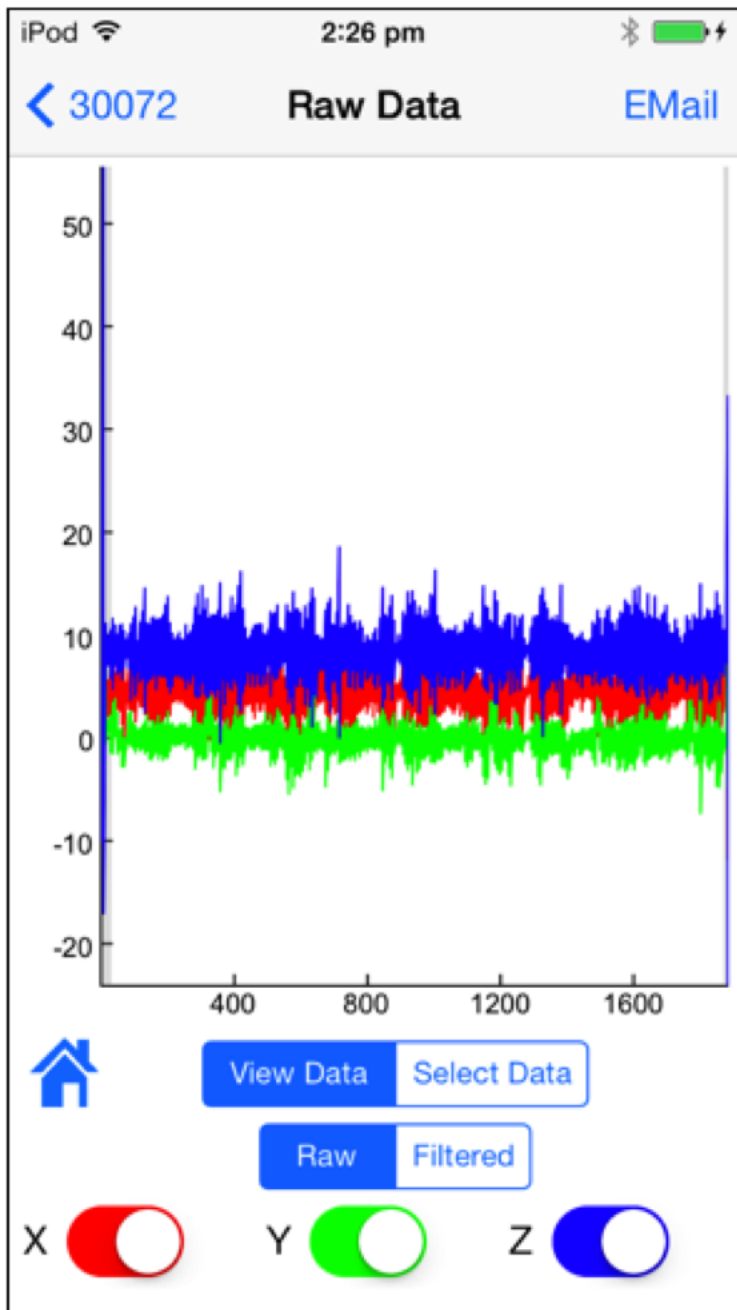


*A Past forgotten is a future repeated*

A \$279, 16 Gb ipod touch incorporates an accelerometer which is capable of measuring whole-body vibration using free WBV ap.

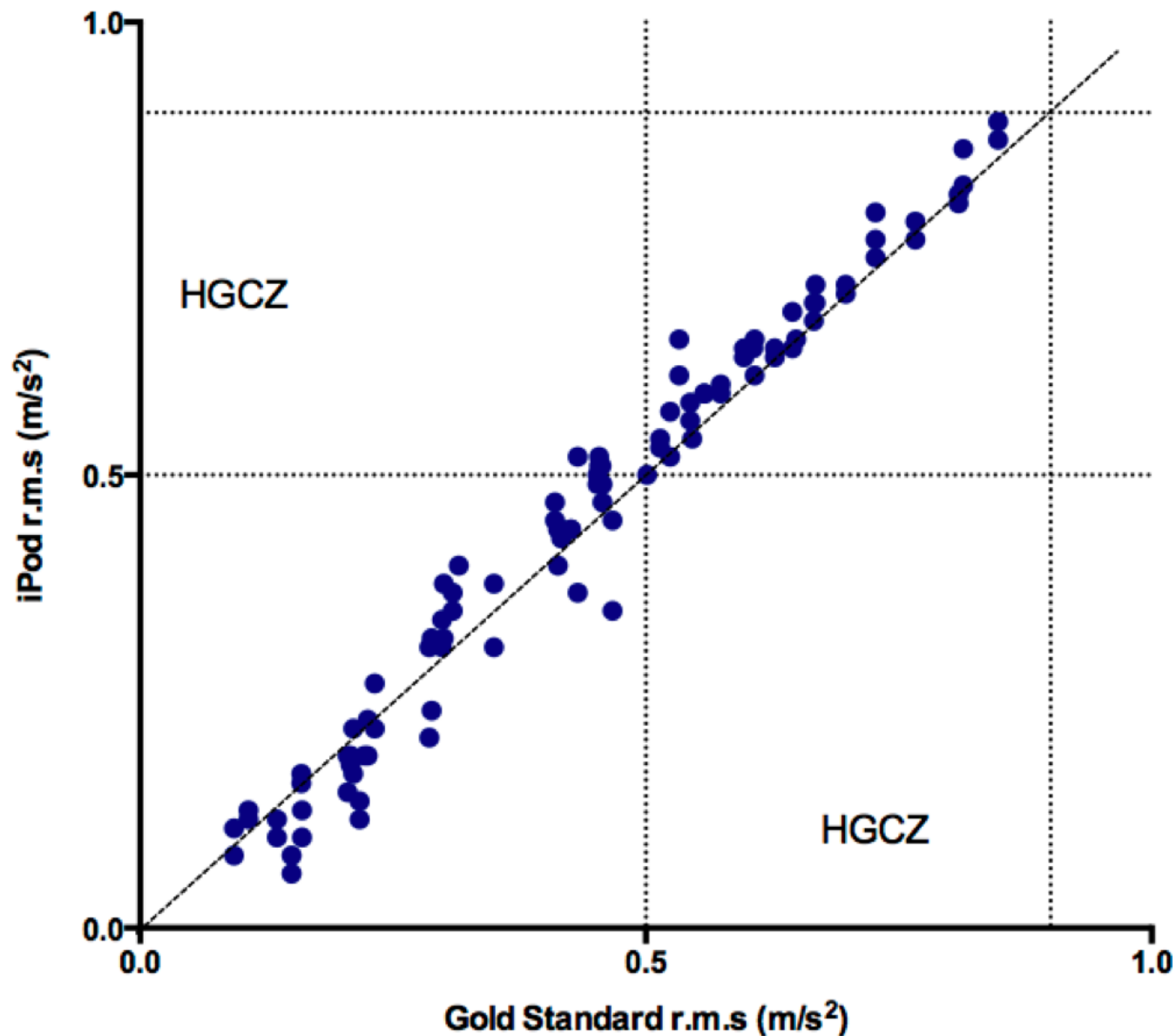
- ✓ Sensitivity =  $0.01 \text{ m/s}^2$
- ✓ Range +/-  $22 \text{ m/s}^2$
- ✓ Sampling rate - approx 90 Hz
- ✓ Stores 2000+ hours data
- ✓ 6 mm x 60 mm x 120 mm
- ✓ >24 hour collection time







## WBV iOS ap accuracy

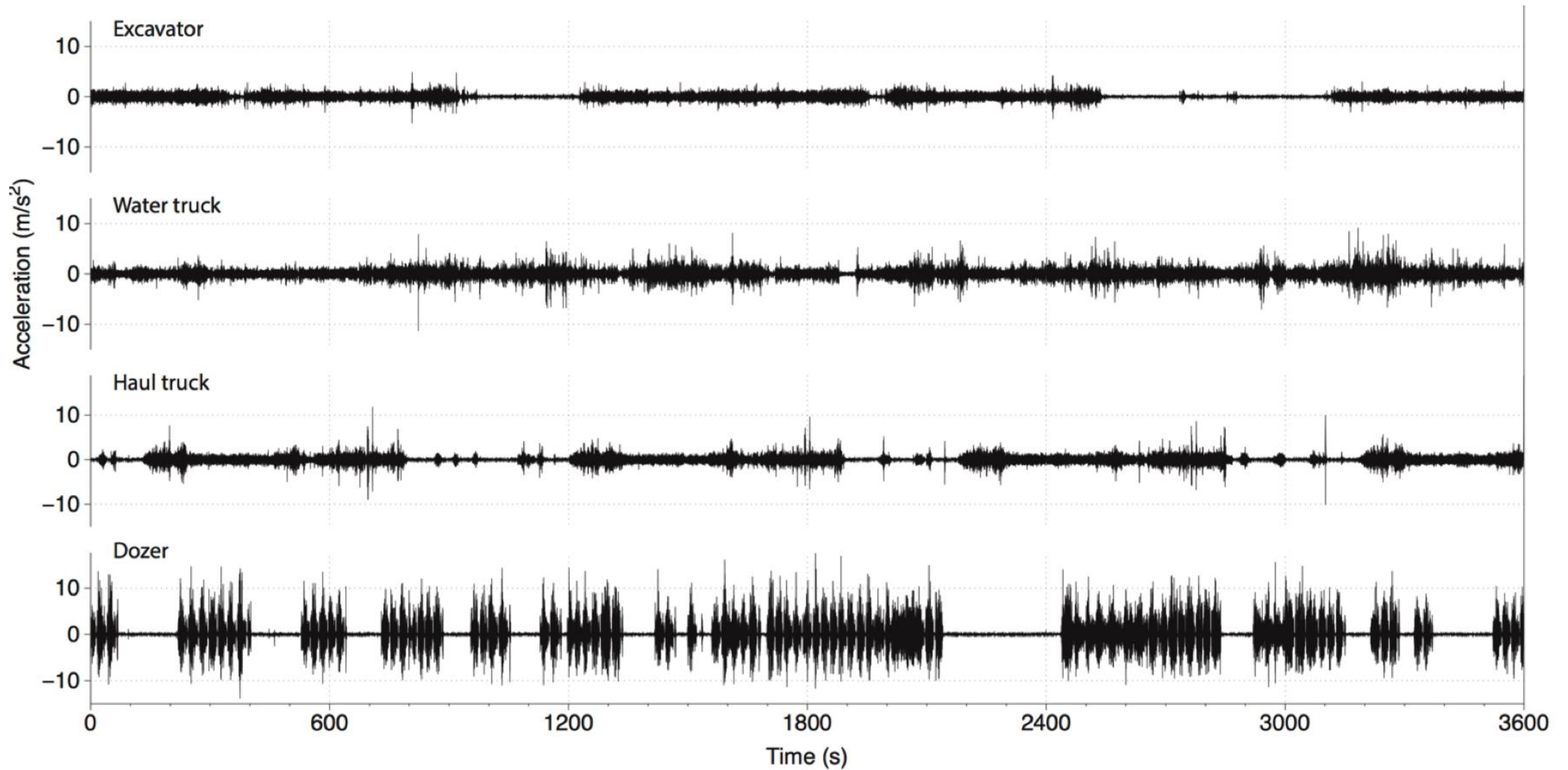


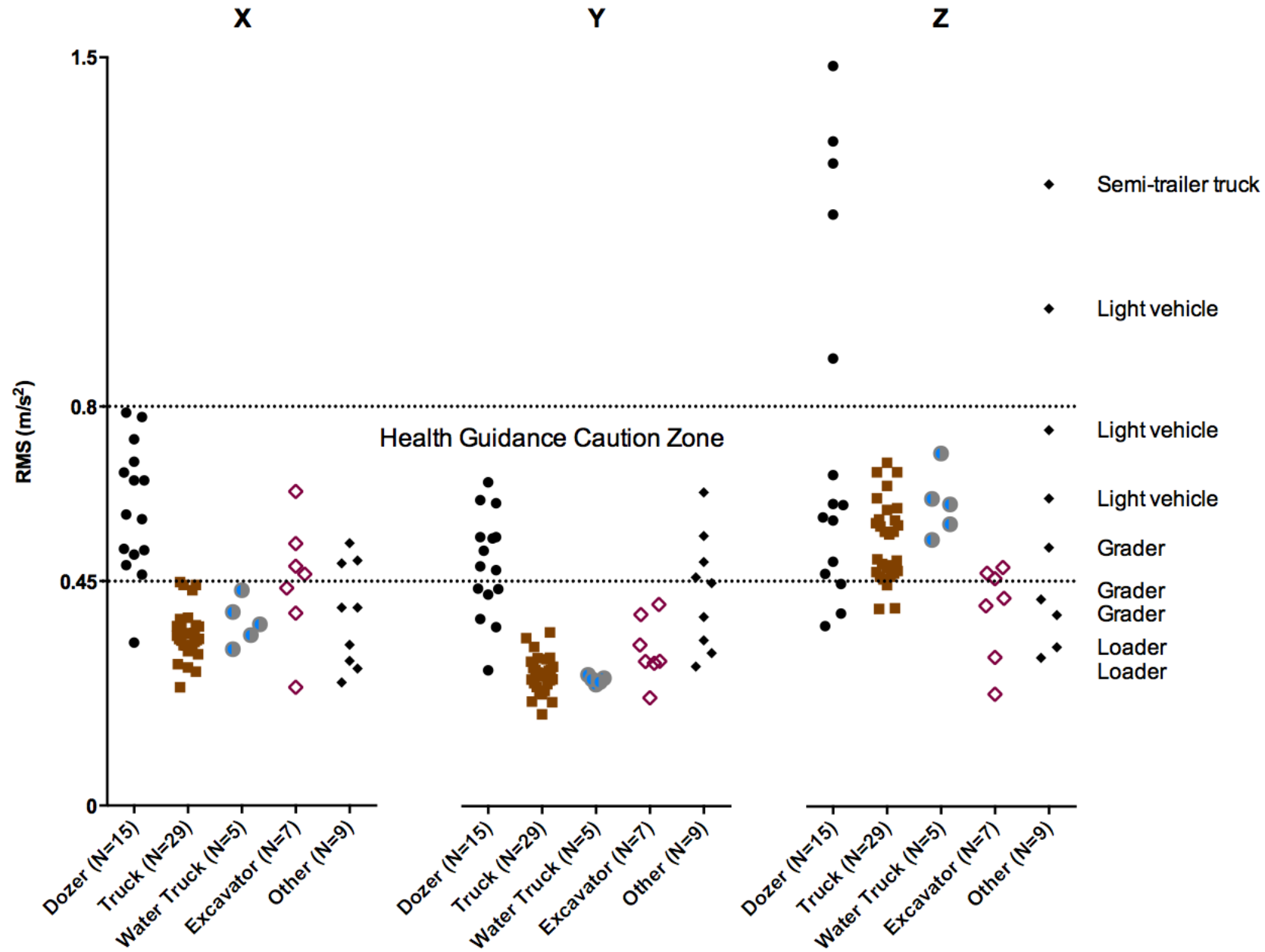
Wolfgang, R. & Burgess-Limerick, R. (2014) Using consumer electronic devices to estimate whole-body vibration exposure. *Journal of Occupational and Environmental Hygiene*. 11:6, D77-D81.

Wolfgang, R., Di Corletto, L., & Burgess-Limerick (2014). Can an iPod Touch be used to assess whole-body vibration associated with mining equipment? *The Annals of Occupational Hygiene*, 58, 1200-1204.

Burgess-Limerick, R. & Lynas, D. (2015) An iOS application for evaluating whole-body vibration within a workplace risk management process. *Journal of Occupational and Environmental Hygiene*, 12, D137-D142.

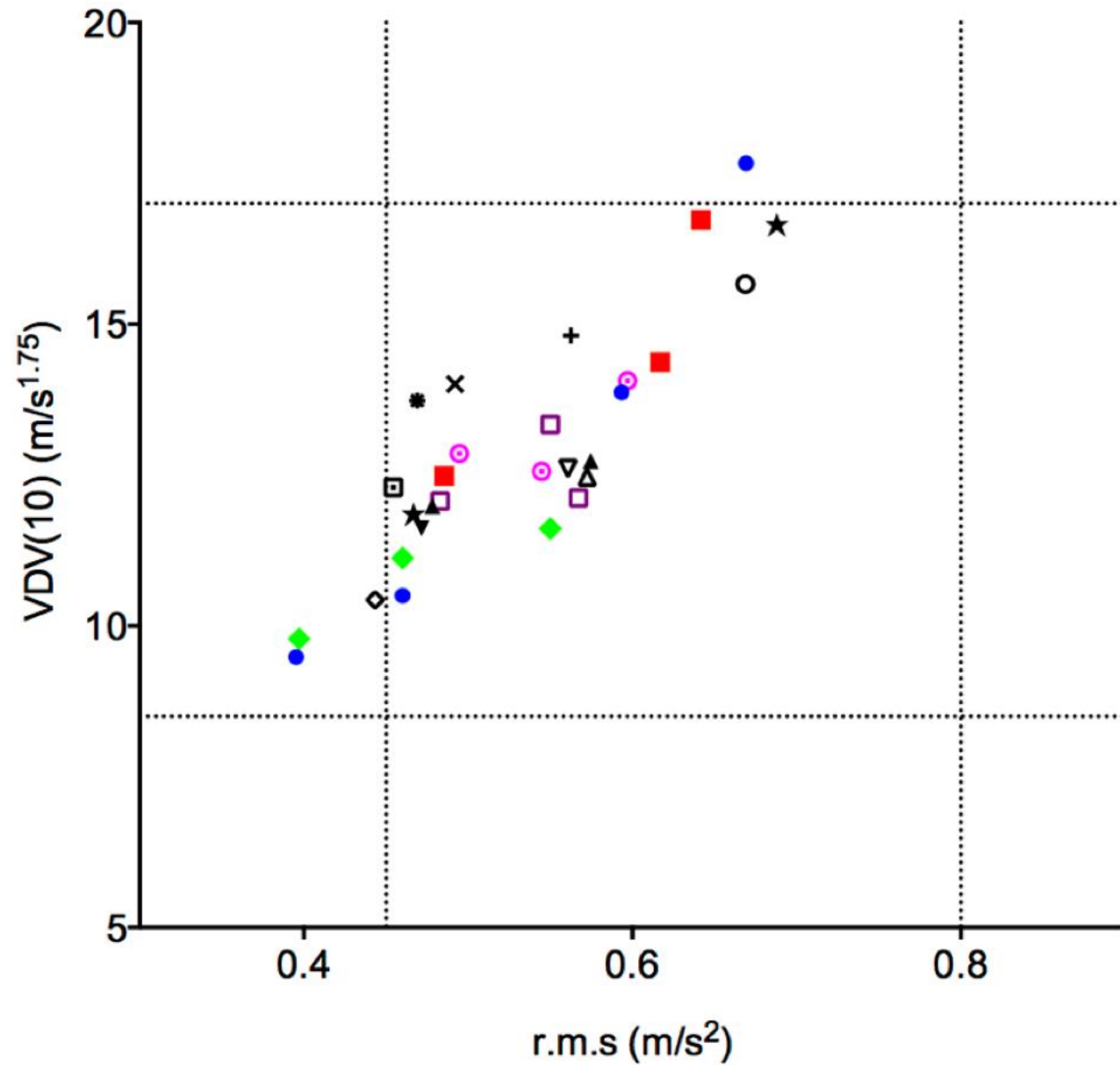
# Surface Coal Mining Mobile Plant





65 long duration measurements from equipment in operation at a surface coal mine (mean duration 317 minutes)

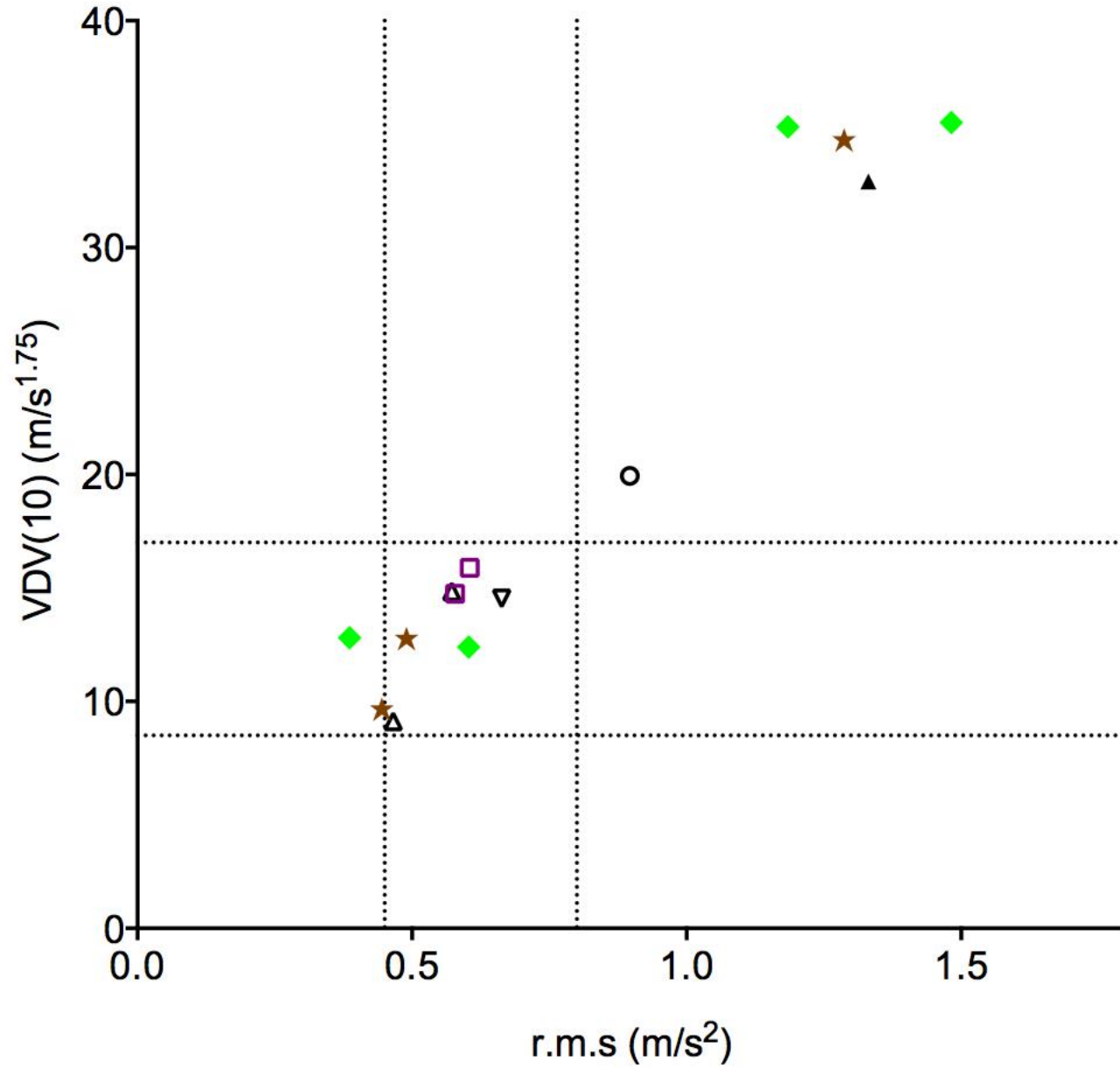
## Dump trucks



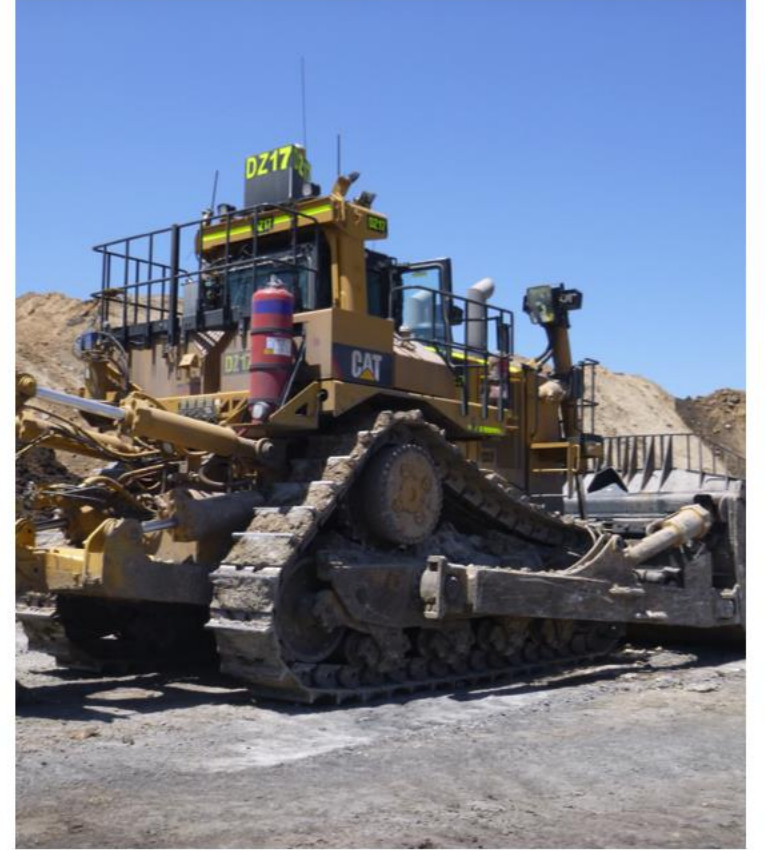
- RD10
- RD11
- ▲ RD12
- ▼ RD2
- ◆ RD32
- RD33
- RD34
- △ RD35
- ▽ RD37
- ◇ RD39
- RD5
- ★ RD60
- + RD62
- × RD63
- ◉ RD67
- ◻ RD9



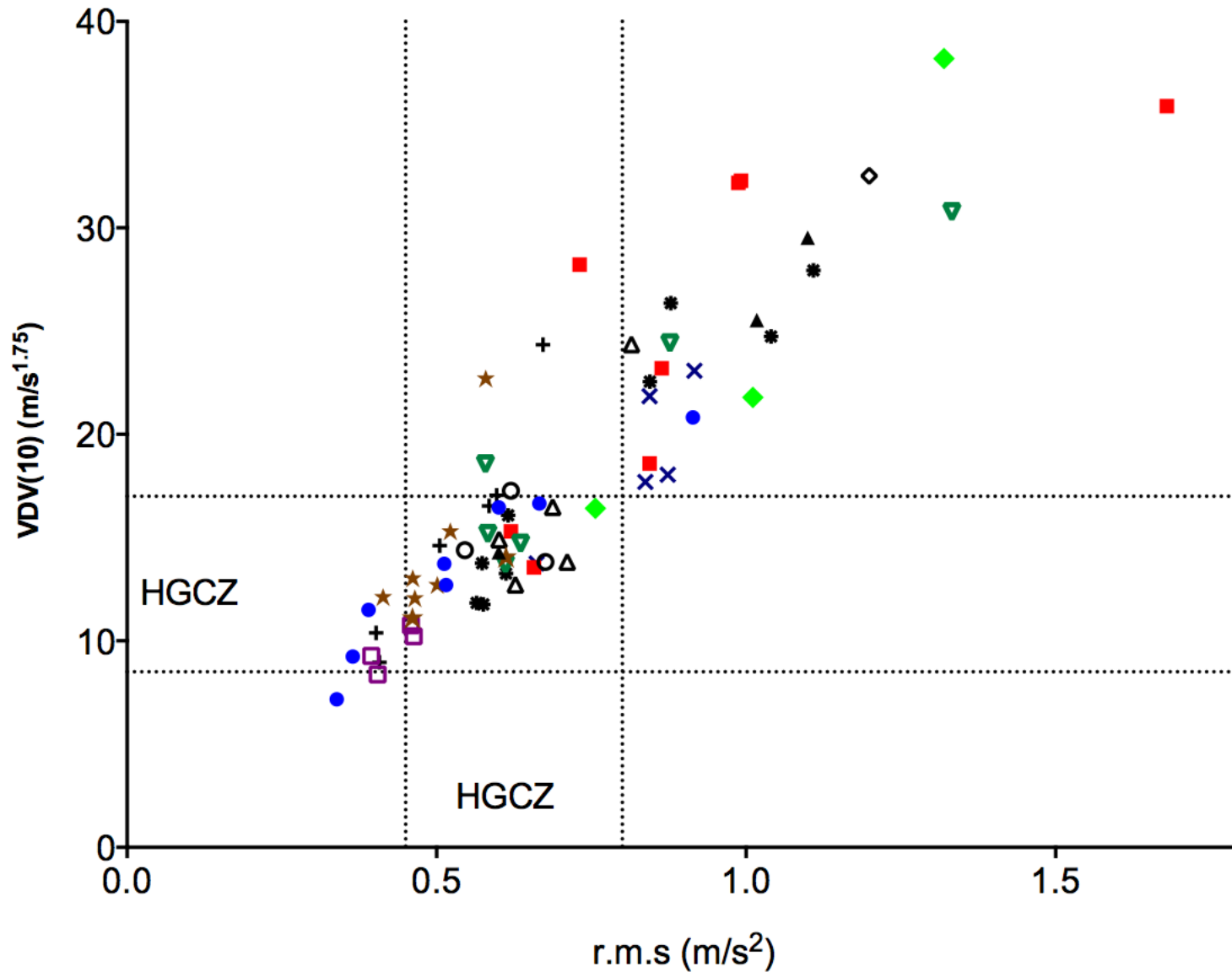
# Dozers



- ▲ DZ1
- ★ DZ10
- ◆ DZ11
- ZD17
- DZ4
- △ DZ5
- ▽ DZ6



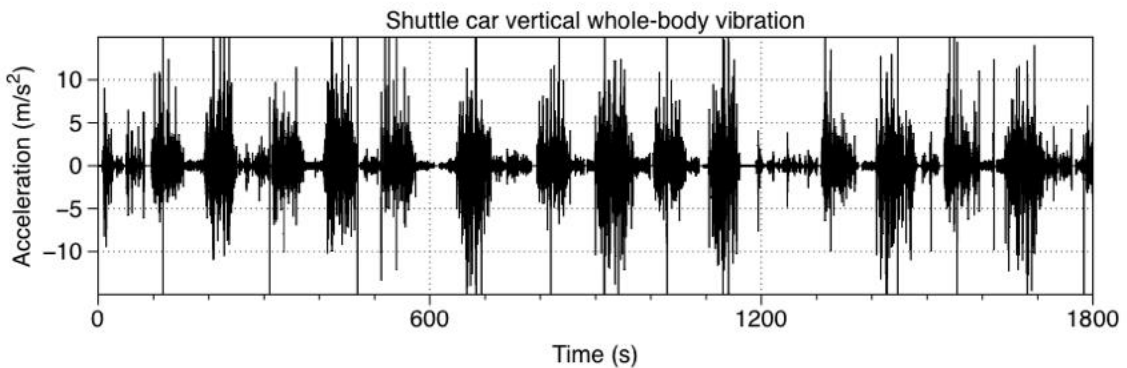
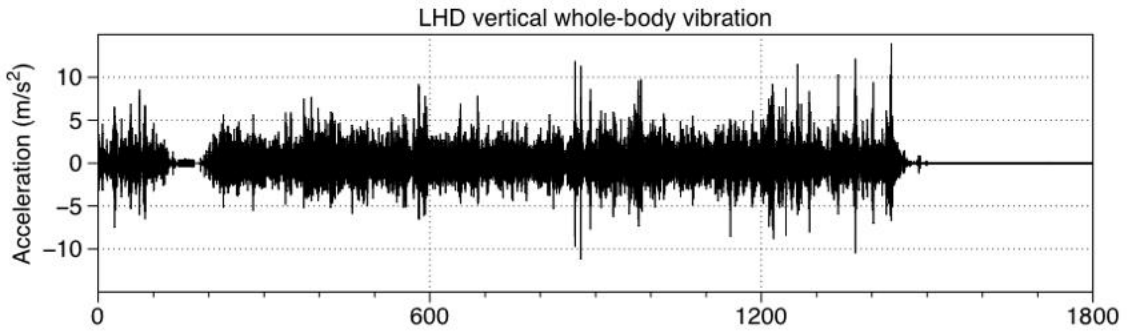
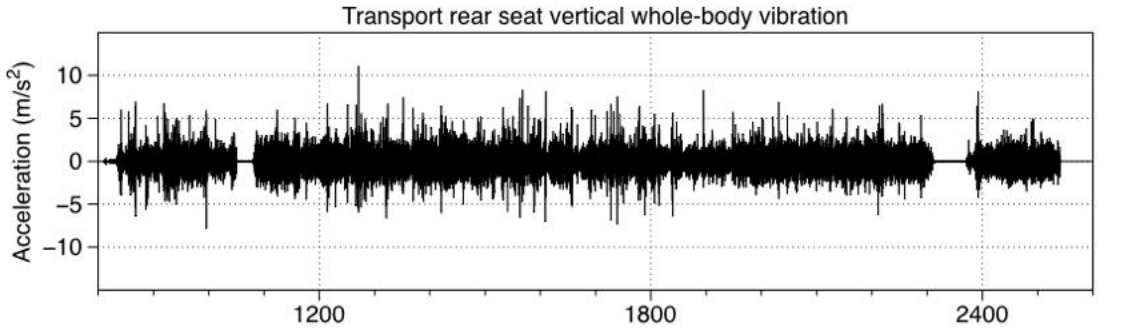
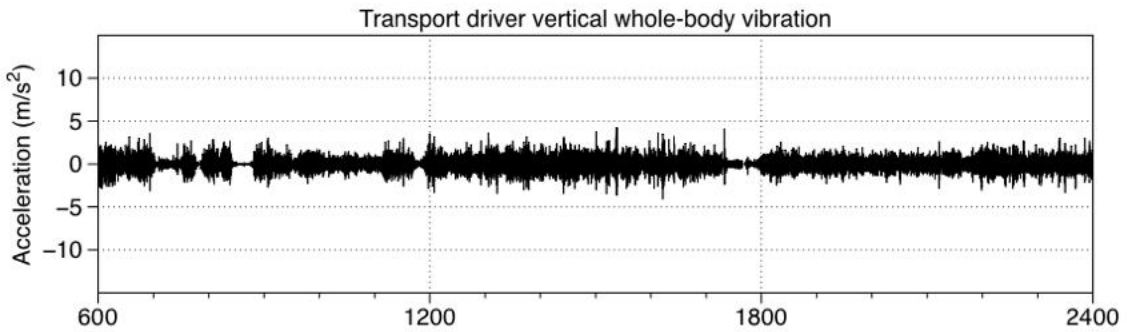
# Dozers

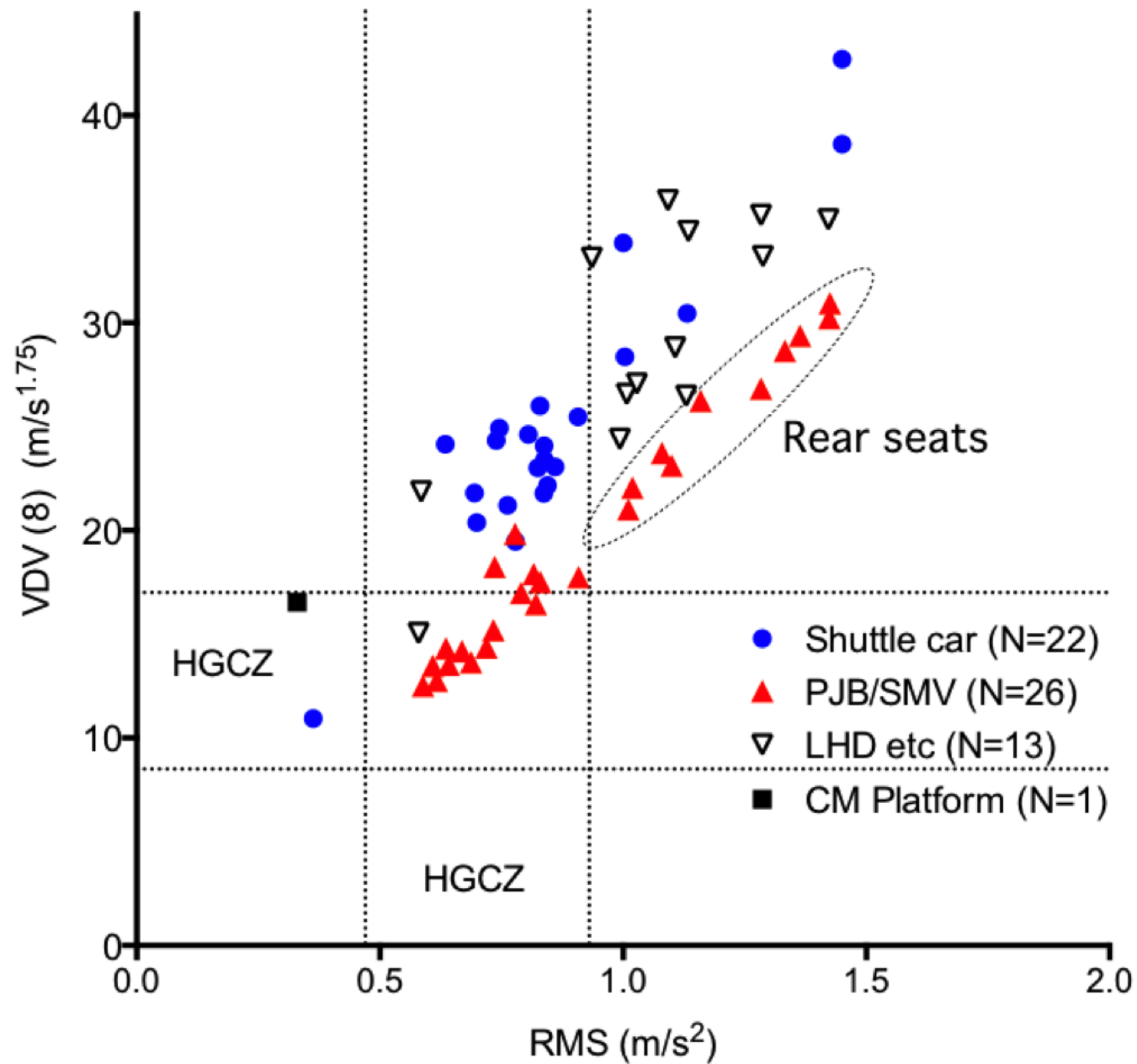


Additional long duration measurements from dozers in operation at a surface coal mine (mean duration 440 minutes)

Further work underway to determine causes of extreme vibration values

# Underground Coal Mining Mobile Plant





62 duration measurements from equipment in operation at three underground coal mines (mean duration 71 minutes)

Further work underway to examine causes of high vibrations





*A Past forgotten is a Future repeated*

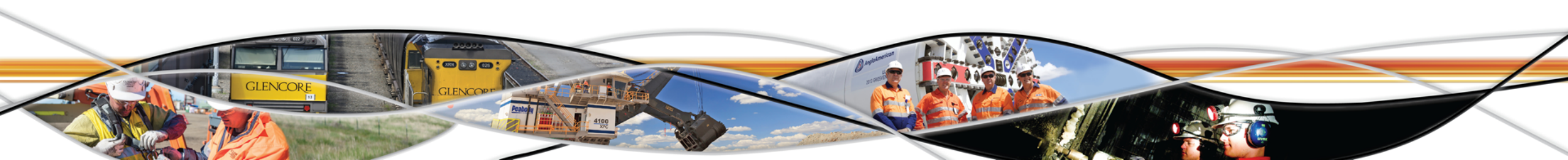
## Conclusions

Management of whole body vibration exposure requires regular measurements in conjunction with a comprehensive whole body vibration management plan

Free WBV iOS application is a simple and effective means of gathering the measurements required

The screenshot shows a web browser displaying the 'Whole-body vibration management' page. The page title is 'Whole-body vibration management'. The main content includes a paragraph about mining equipment vibration exposure, a list of 'Whole-Body Vibration resources' (management plan, training slides, user manual, technical specifications, publications, and WBVAnalysis), and logos for SMI MISHC, Health & Safety Trust, The University of Queensland, and ACARP. A banner image at the bottom shows mining equipment like a yellow haul truck and a bulldozer.

[ergonomics.uq.edu.au/wbv](http://ergonomics.uq.edu.au/wbv)





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# Acknowledgments



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**ACARP**

Australian Coal Association Research Program project C23022

Project website: [ergonomics.uq.edu.au/wbv](http://ergonomics.uq.edu.au/wbv)

