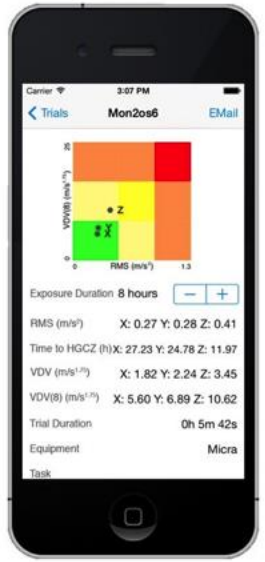
Measuring whole-body vibration at surface and underground coal mines



WBV

Available on the App Store

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SMI MISHC
Minerals Industry Safety & Health Centre

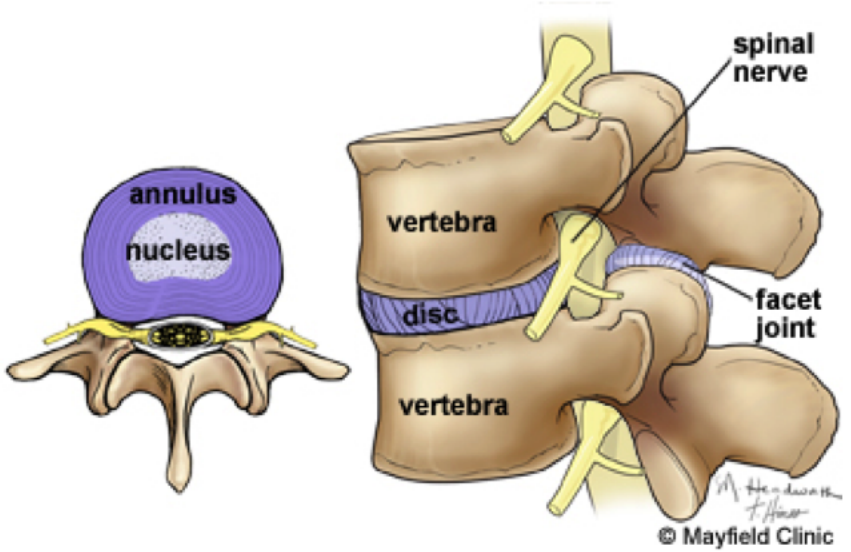
Leading Risk, Health and Safety Management for the minerals industry

ACARP

CS Health & Safety Trust

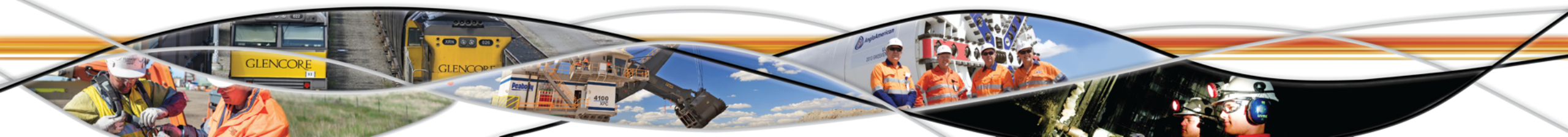
QUEENSLAND MINING INDUSTRY HEALTH & SAFETY CONFERENCE 2016

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

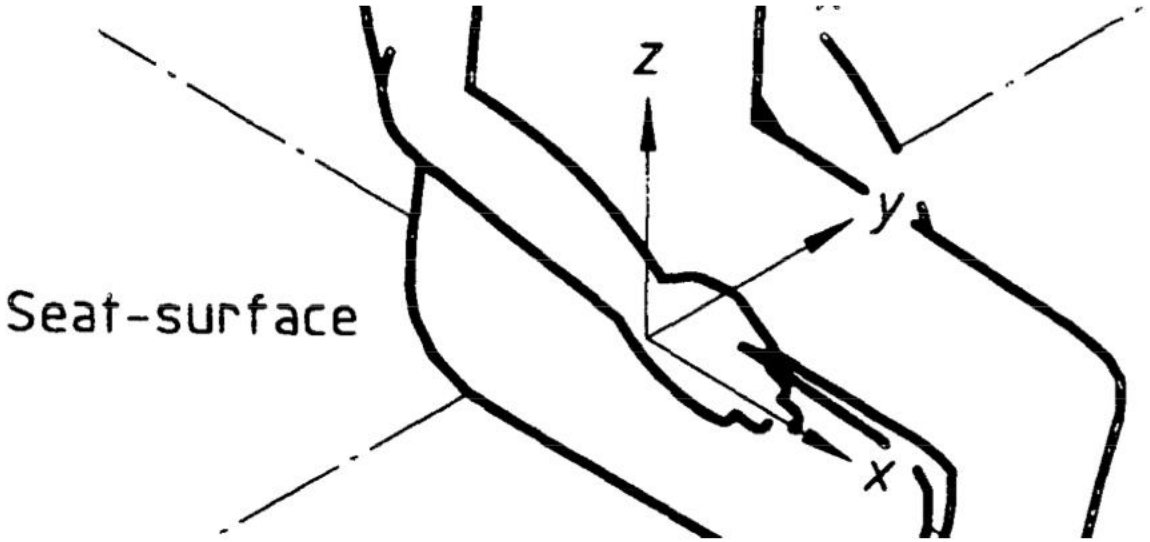


Vertebral endplate damage => reduced intervertebral disc nutrition

Most sensitive to 2-10 Hz vibrations



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 vibation and shock—Evaluation of human exposure to whole-body vibration, Part 1 General requirements]

Two primary measures of vibration amplitude

root mean squared amplitude (**r.m.s**) m/s ^{2}

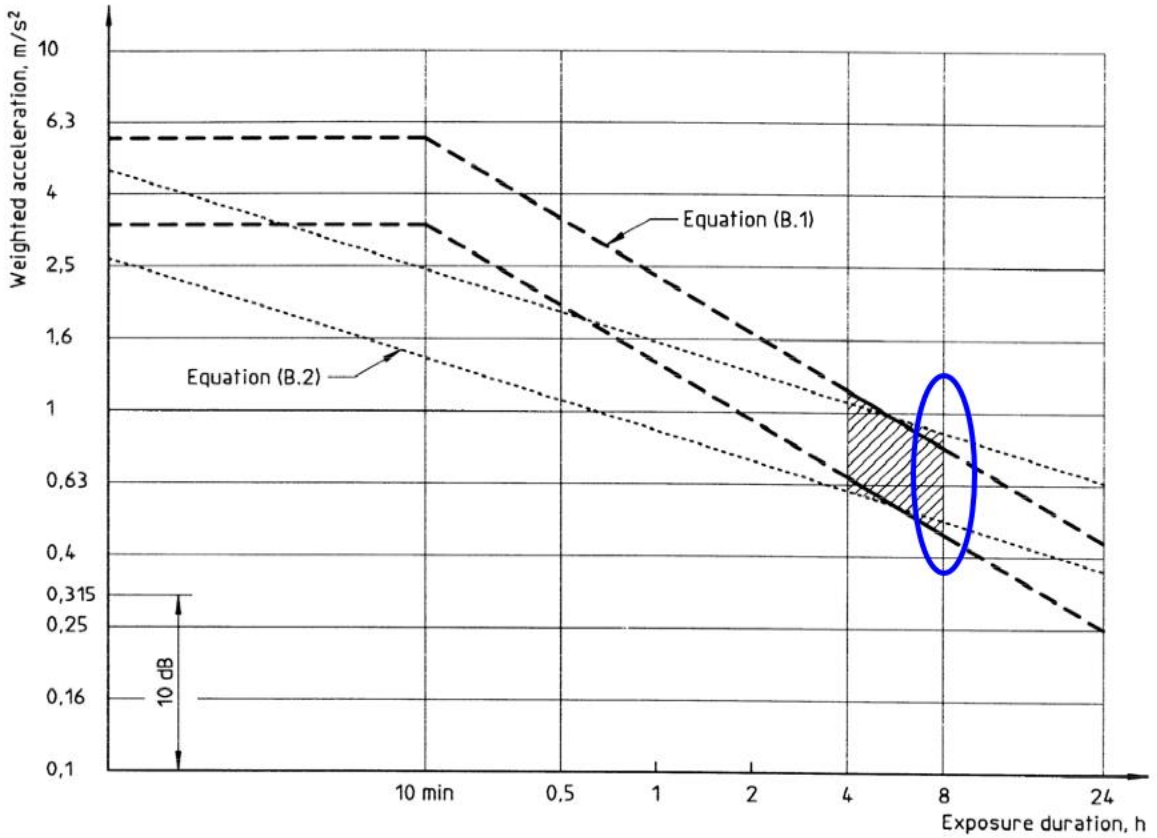
$$a_w = \left[\frac{1}{T} \int_0^T a_w^2(t)\, dt \right]^{\frac{1}{2}}$$

Vibration Dose Value (**VDV**) m/s $^{1.75}$

$$VDV = \left\{ \int_0^T [a_w(t)]^4 \, dt \right\}^{\frac{1}{4}}$$

VDV more sensitive to high amplitude jolts & jars

AS2670.1 / ISO 2631.1 Health Guidance Caution Zone



0.93 m/s²

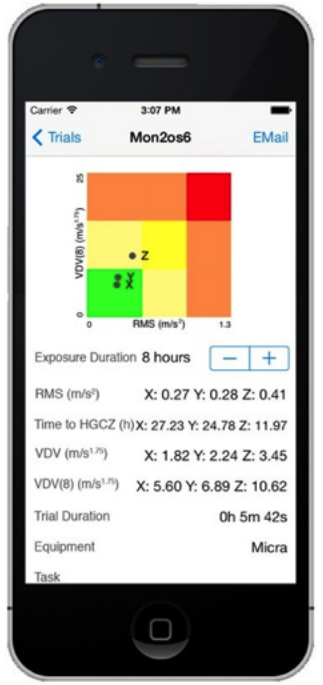
0.47 m/s²

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.

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

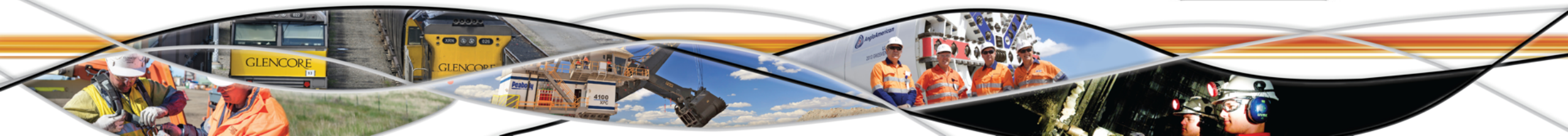
A $279, 16 Gb ipod touch incorporates an accelerometer which is capable of measuring whole-body vibration using free WBV ap.

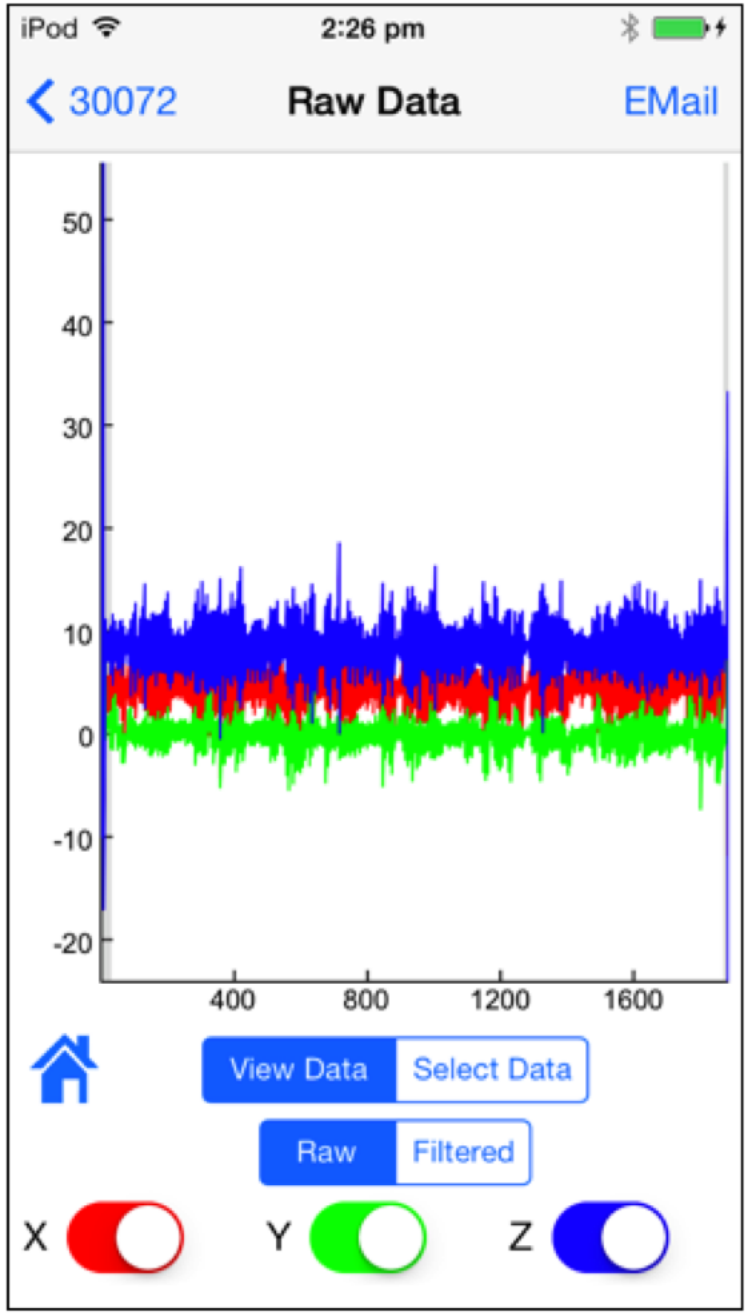
- ☑ Sensitivity = 0.01 m/s^2
- ☑ Range +/- 22 m/s^2
- ☑ Sampling rate - approx 90 Hz
- ☑ Stores 2000+ hours data
- ☑ 6 mm x 60 mm x 120 mm
- ☑ >24 hour collection time

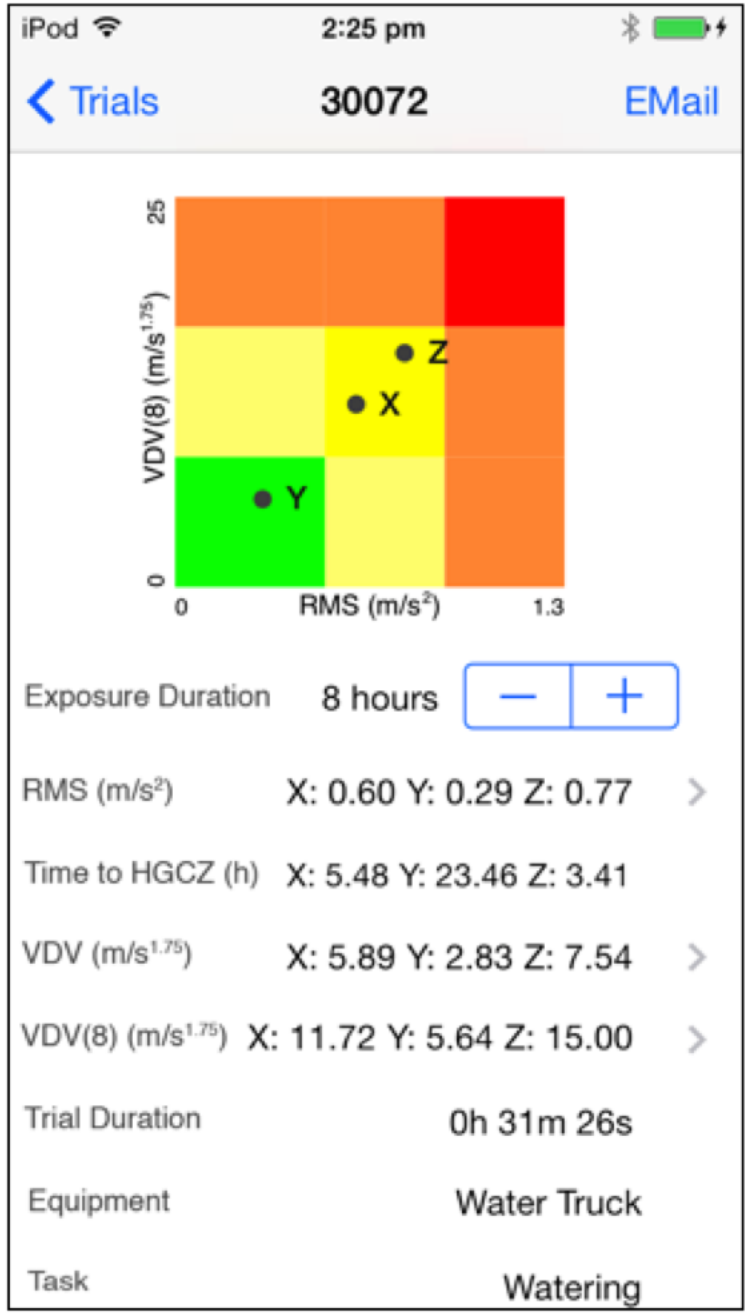


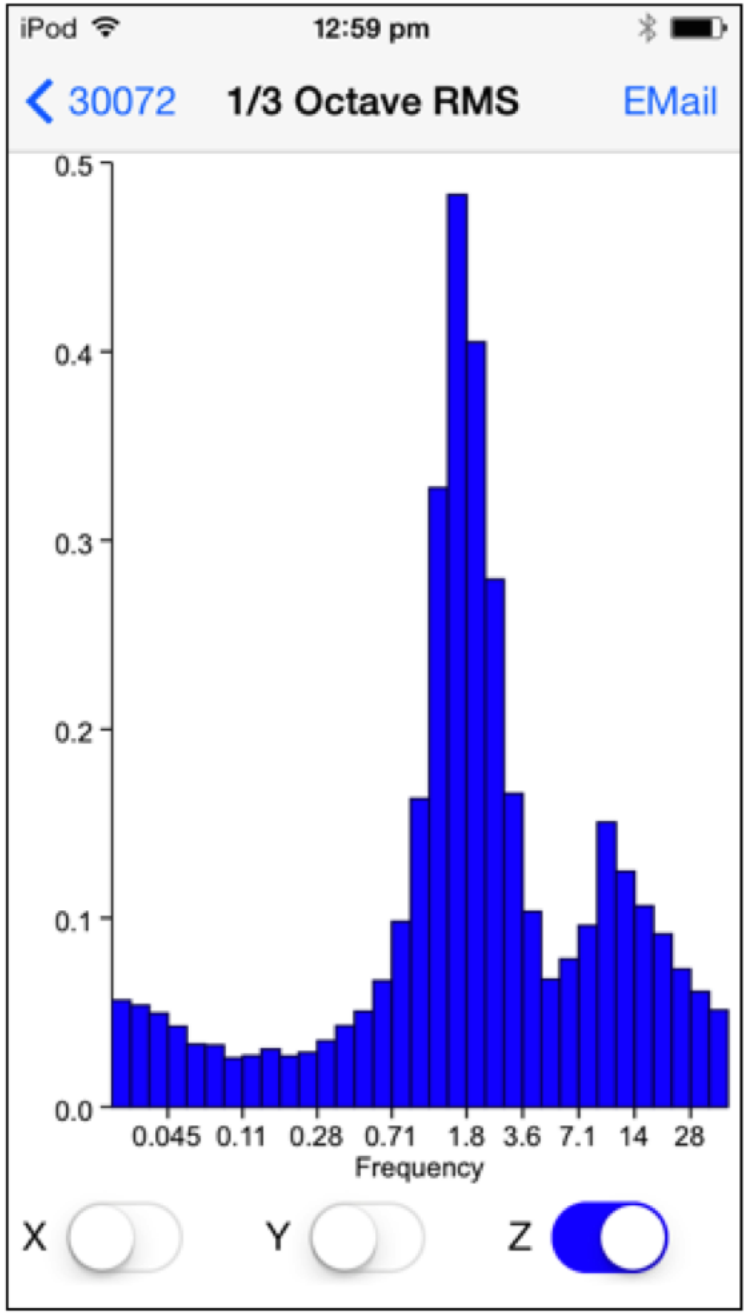
WBV

Available on the App Store

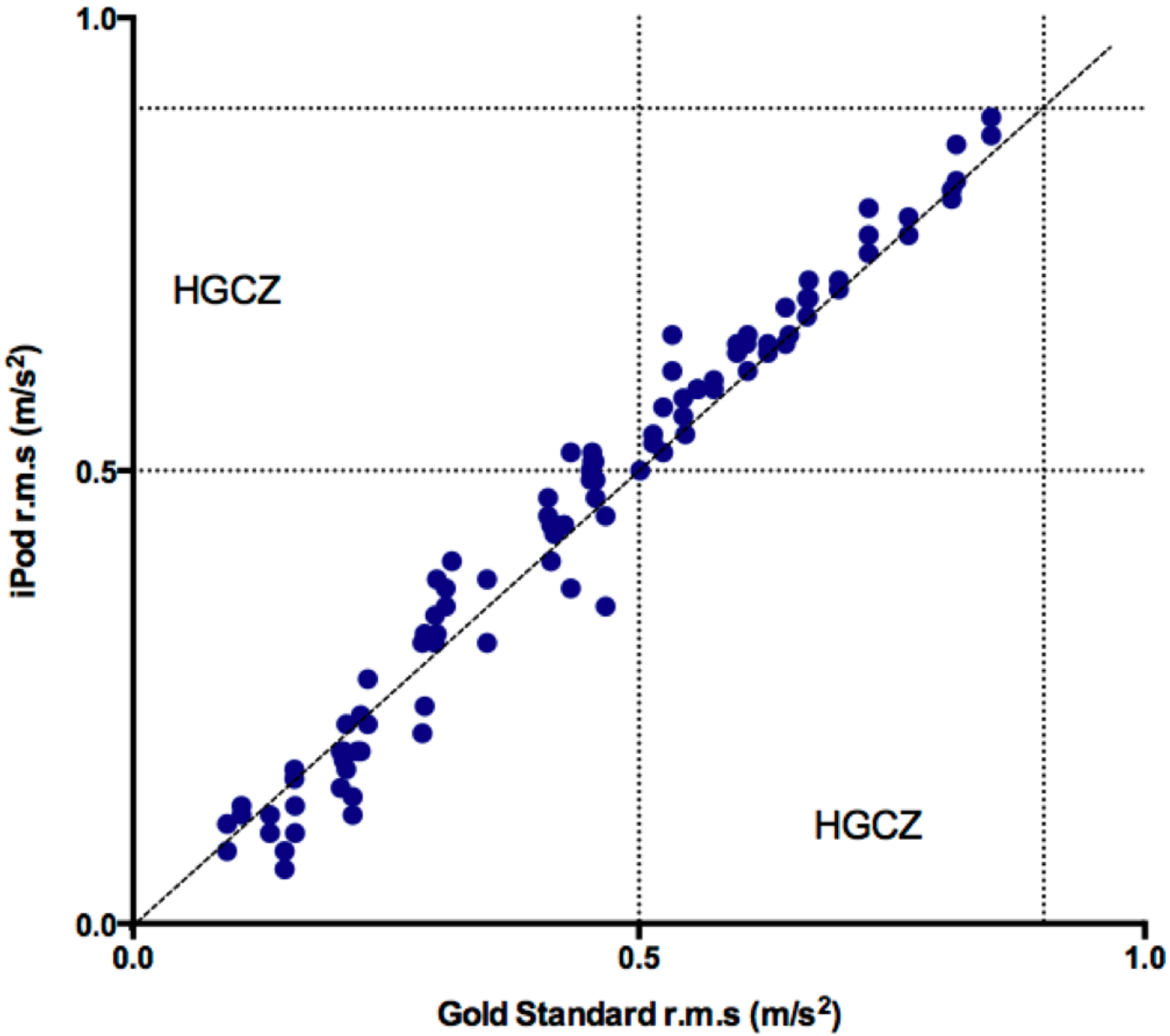



iPod
2:26 pm
30072
Raw Data
EMail
50
40
30
20
10
0
-10
-20
400
800
1200
1600
View Data
Select Data
Raw
Filtered
X
Y
Z


iPod
2:25 pm
Trials
30072
EMail
25
0
VDV(8) (m/s^1.75)
Z
X
Y
0
RMS (m/s^2)
1.3
Exposure Duration
8 hours
RMS (m/s^2)
X: 0.60 Y: 0.29 Z: 0.77
Time to HGCZ (h)
X: 5.48 Y: 23.46 Z: 3.41
VDV (m/s^1.75)
X: 5.89 Y: 2.83 Z: 7.54
VDV(8) (m/s^1.75)
X: 11.72 Y: 5.64 Z: 15.00
Trial Duration
0h 31m 26s
Equipment
Water Truck
Task
Watering


iPod
12:59 pm
30072
1/3 Octave RMS
EMail
0.5
0.4
0.3
0.2
0.1
0.0
0.045
0.11
0.28
0.71
1.8
3.6
7.1
14
28
Frequency
X
Y
Z

WBV iOS ap accuracy

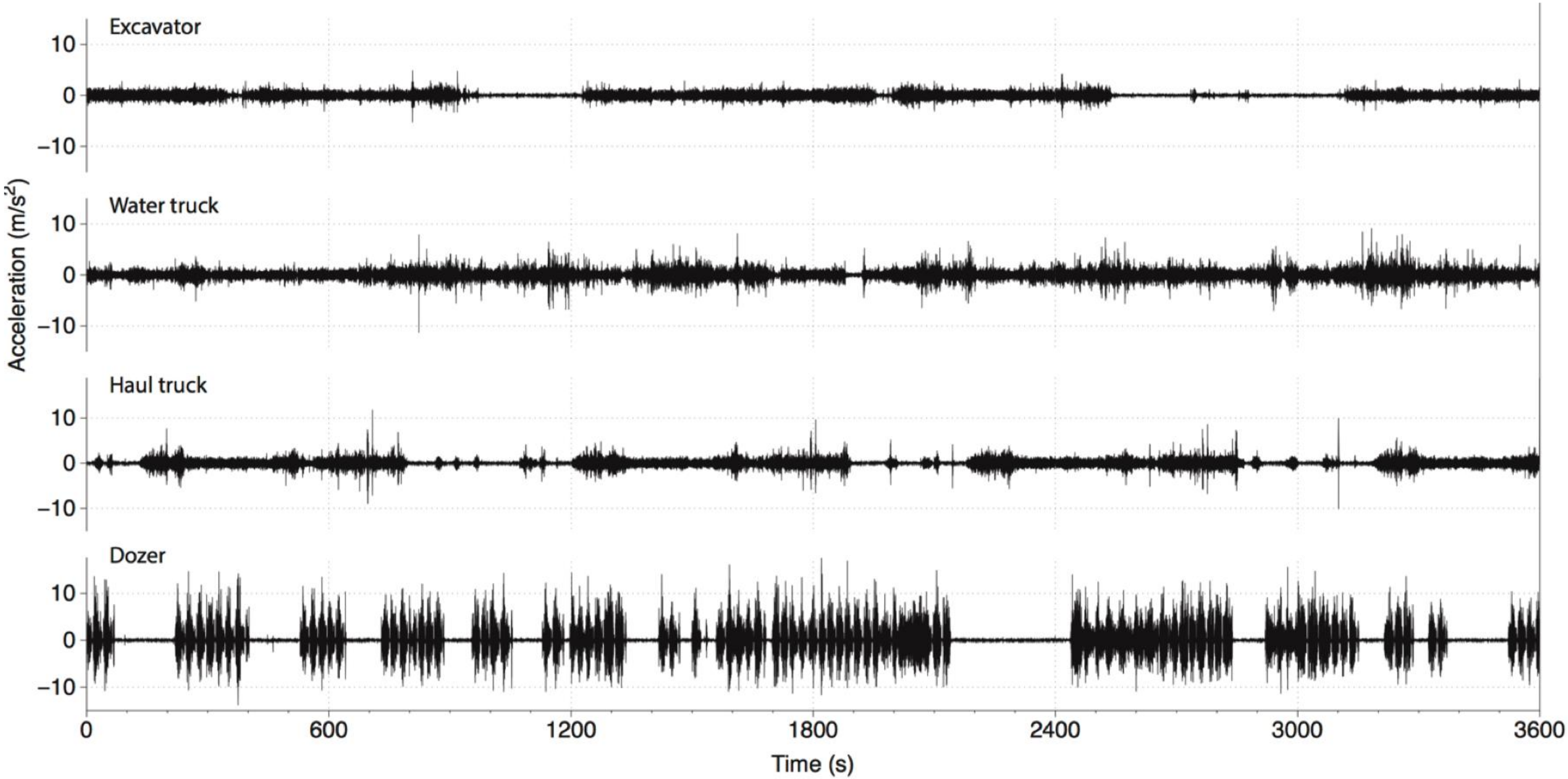


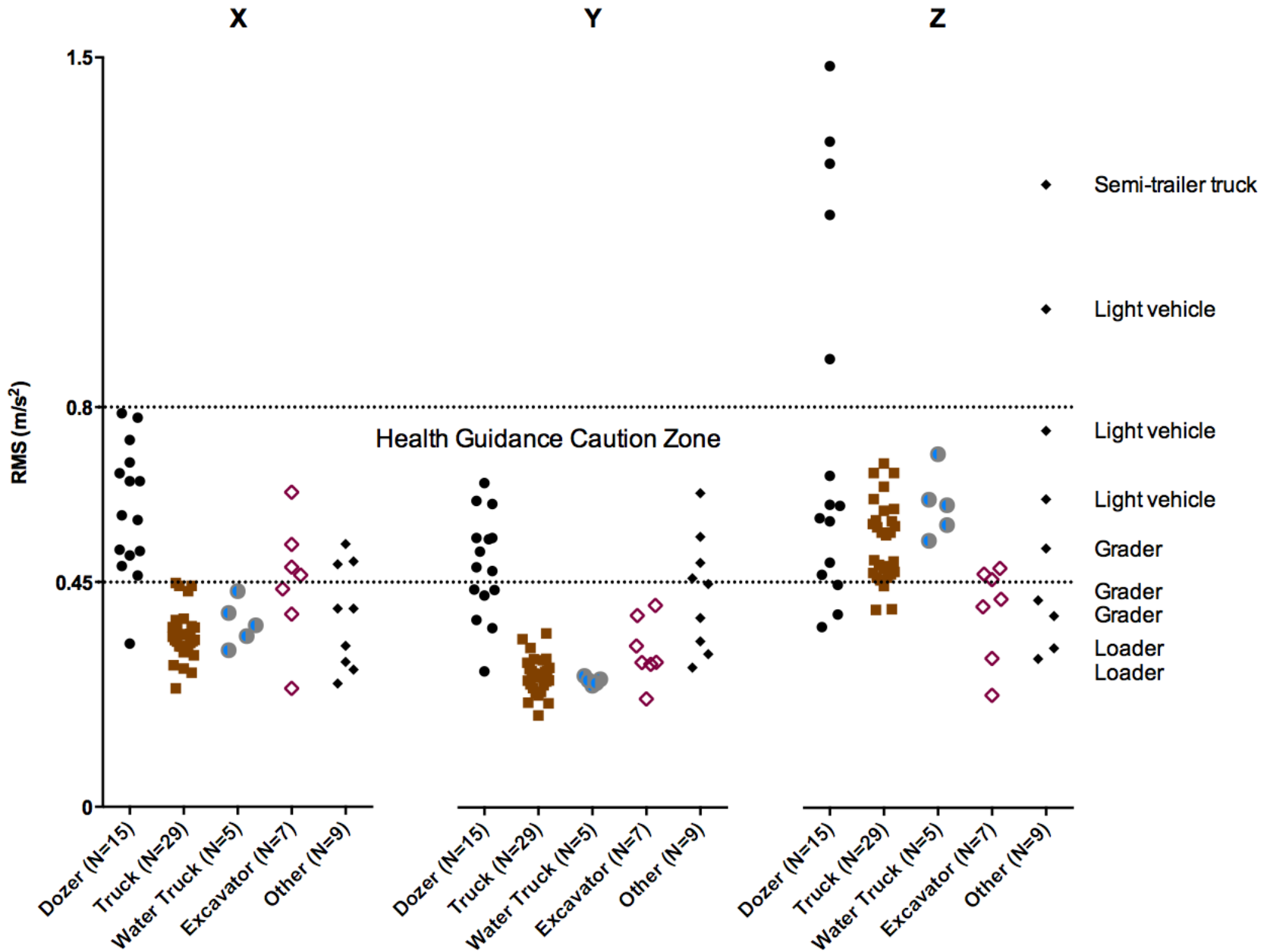
Wolfgang, R. & Burgess-Limerick, R. (2014) Using consumer electronic devices to estimate whole-body vibration exposure. *Journal of Occupational and Environmental Hygiene*. 11:6, D77-D81.

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.

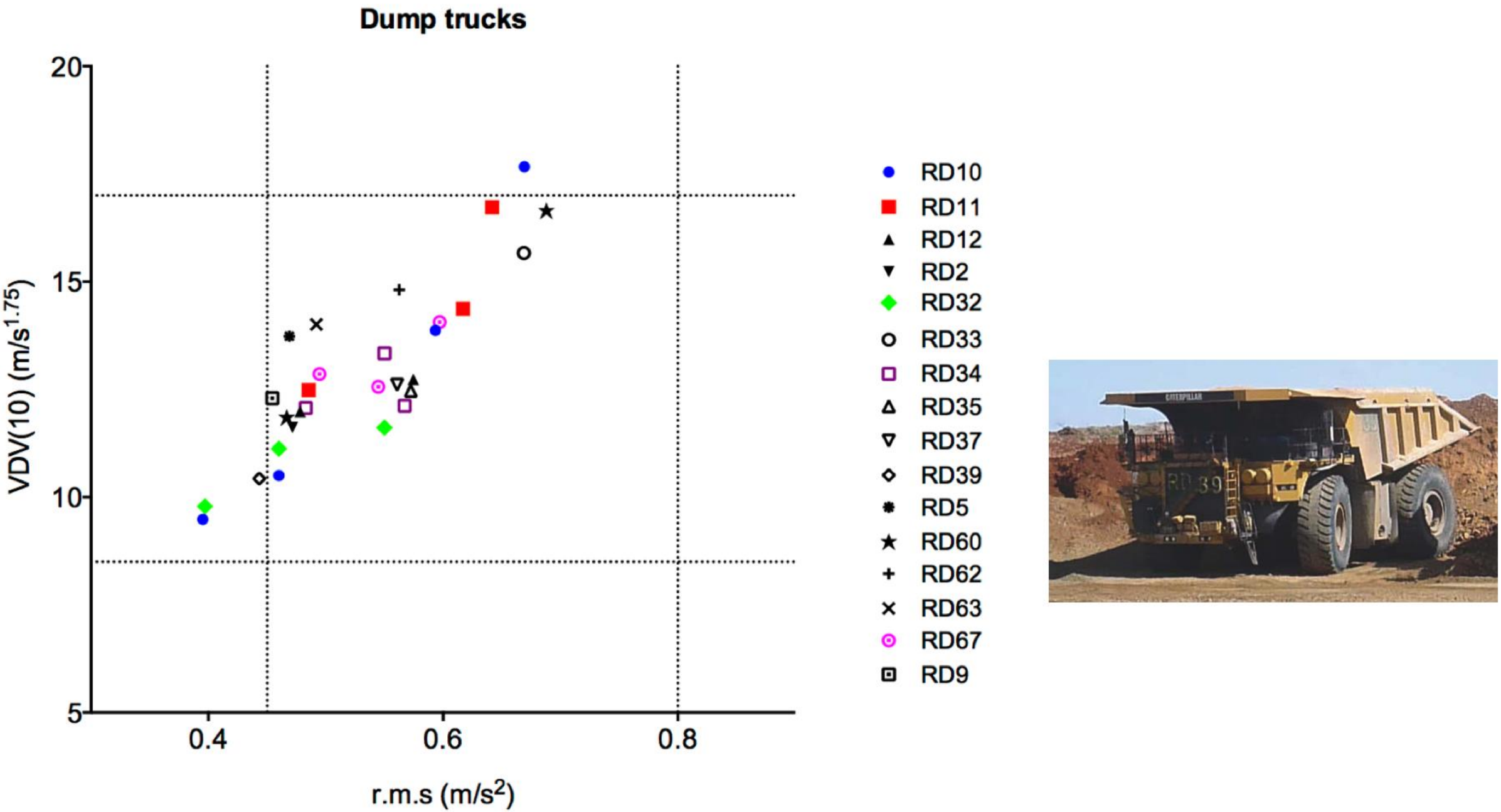
Burgess-Limerick, R. & Lynas, D. (2015) An iOS application for evaluating whole-body vibration within a workplace risk management process. *Journal of Occupational and Environmental Hygiene, 12, D137-D142.*

Surface Coal Mining Mobile Plant

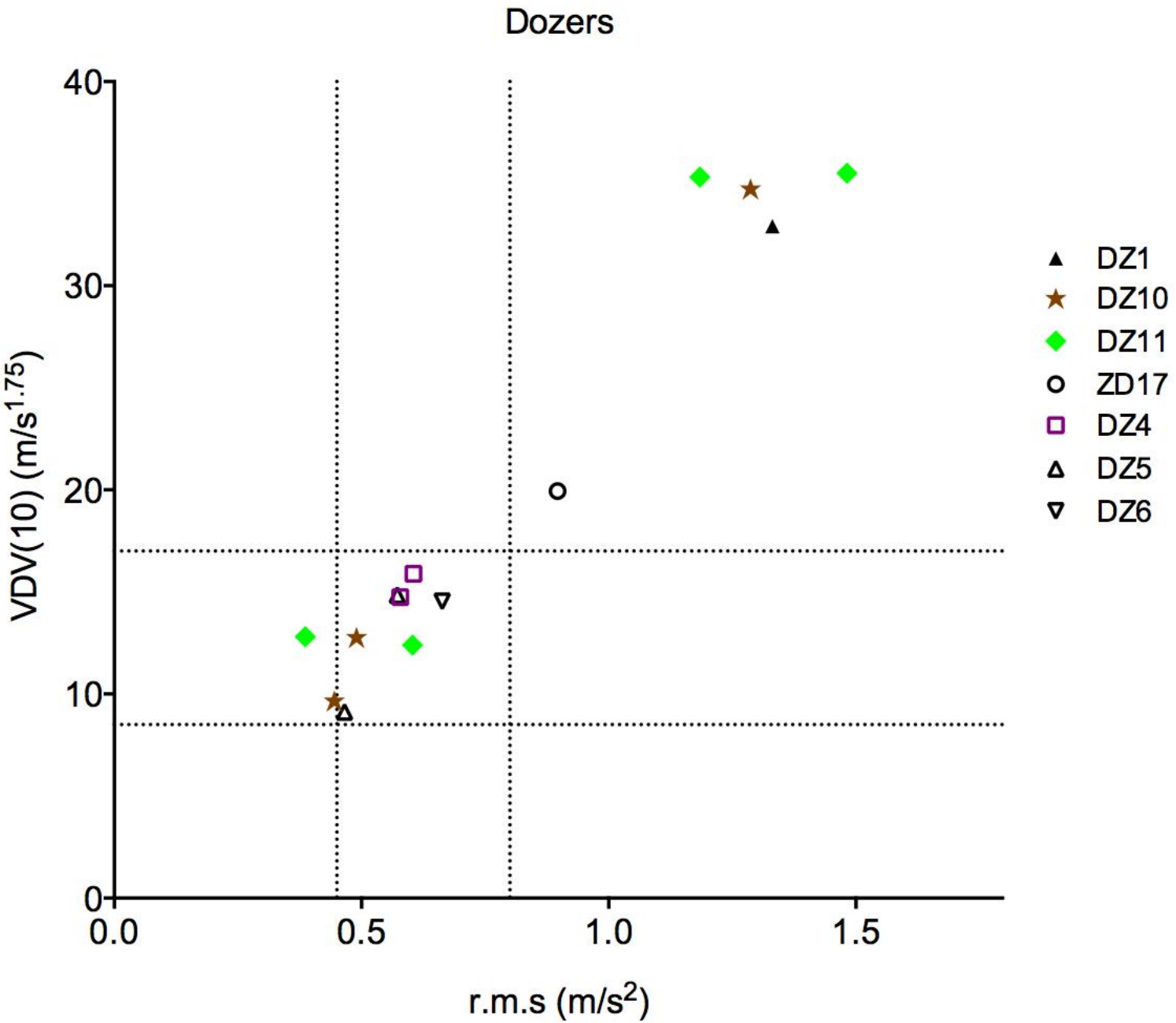


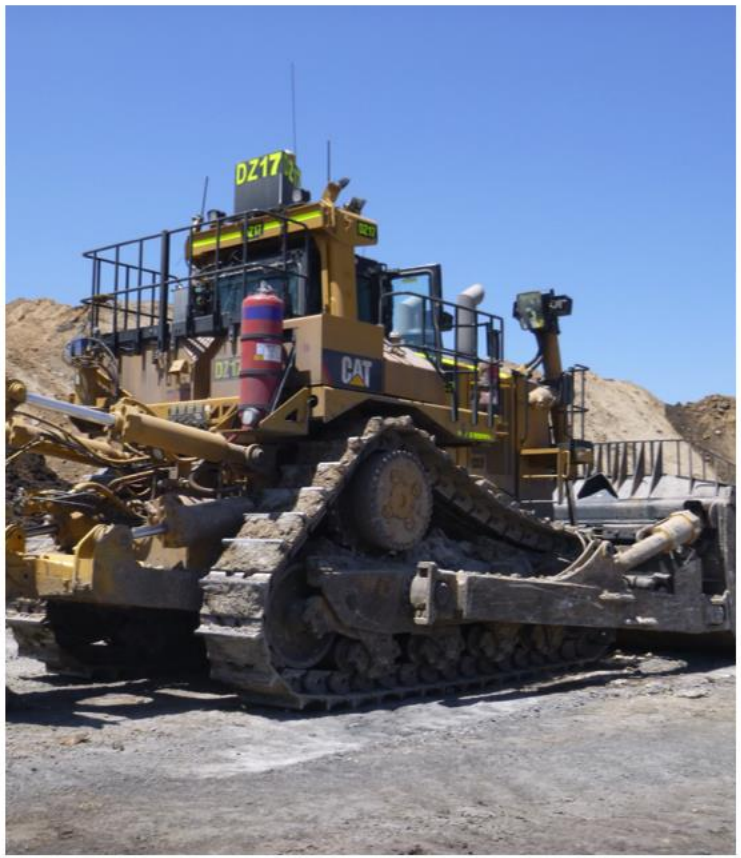


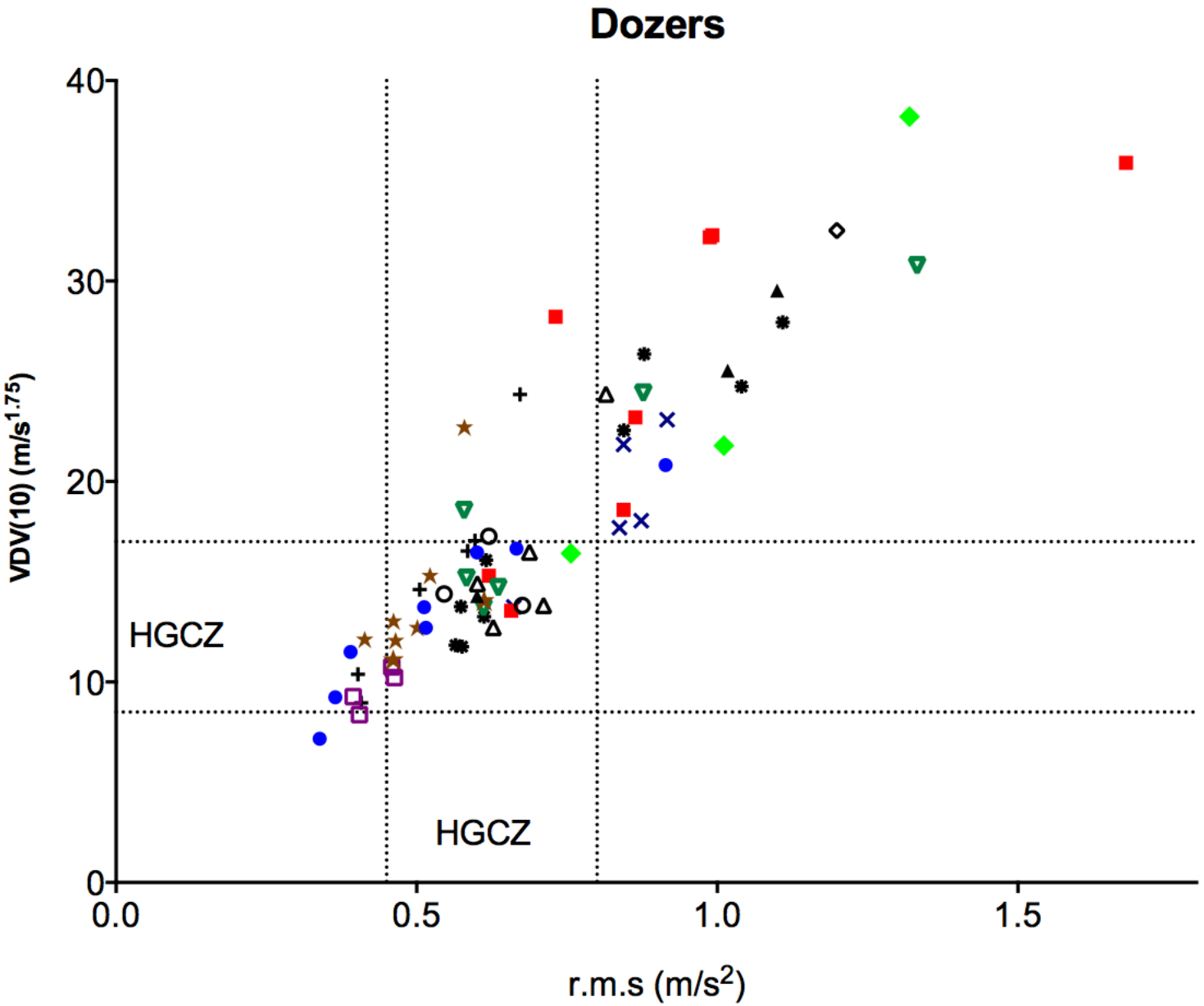
65 long duration measurements from equipment in operation at a surface coal mine (mean duration 317 minutes)


Dump trucks
20
15
10
5
VDV(10) (m/s1.75)
0.4
0.6
0.8
r.m.s (m/s2)
RD10
RD11
RD12
RD2
RD32
RD33
RD34
RD35
RD37
RD39
RD5
RD60
RD62
RD63
RD67
RD9

CATERPILLAR
RD 39

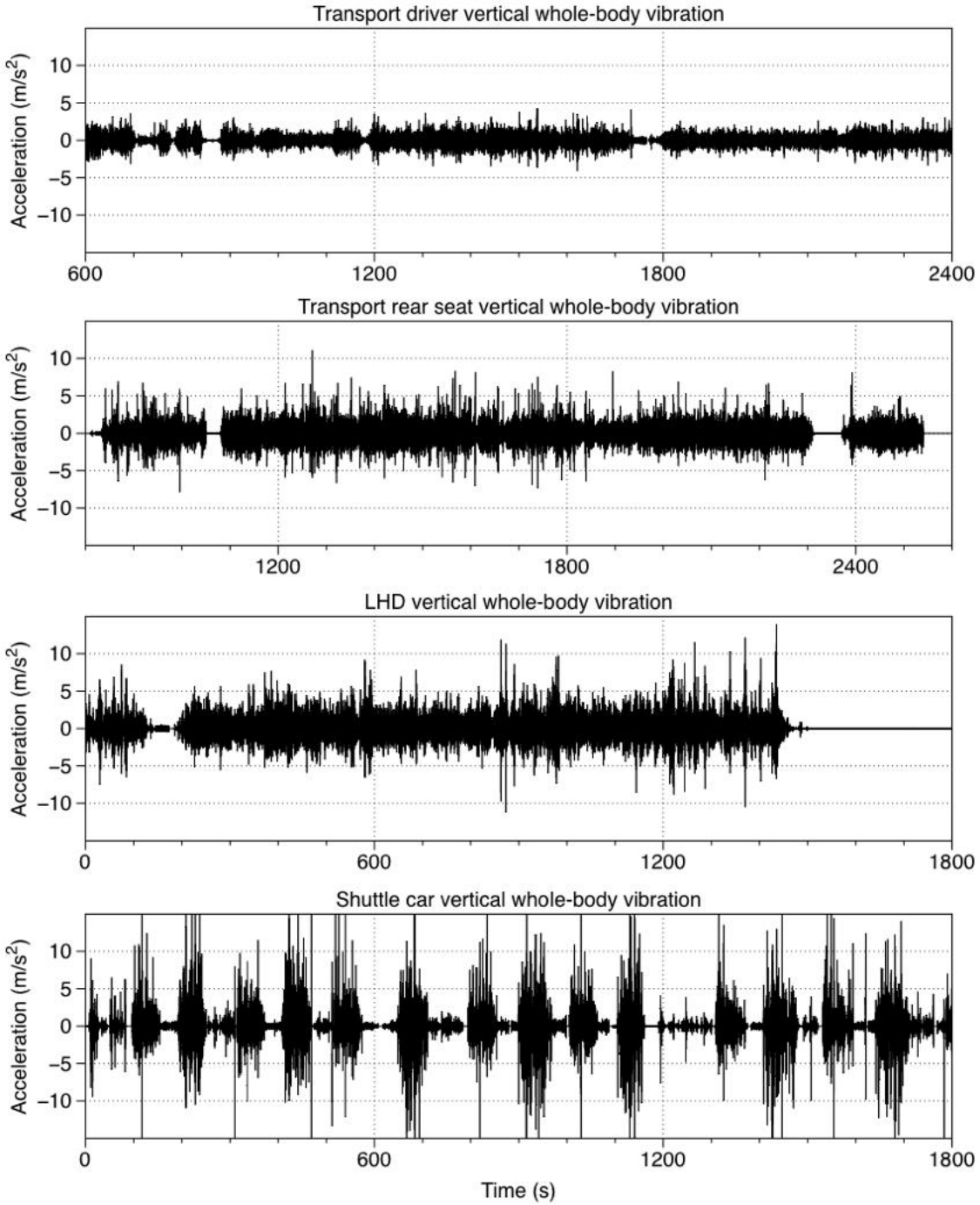

Dozers
40
30
20
10
0
VDV(10) (m/s1.75)
0.0
0.5
1.0
1.5
r.m.s (m/s2)
DZ1
DZ10
DZ11
ZD17
DZ4
DZ5
DZ6


DZ17
CAT

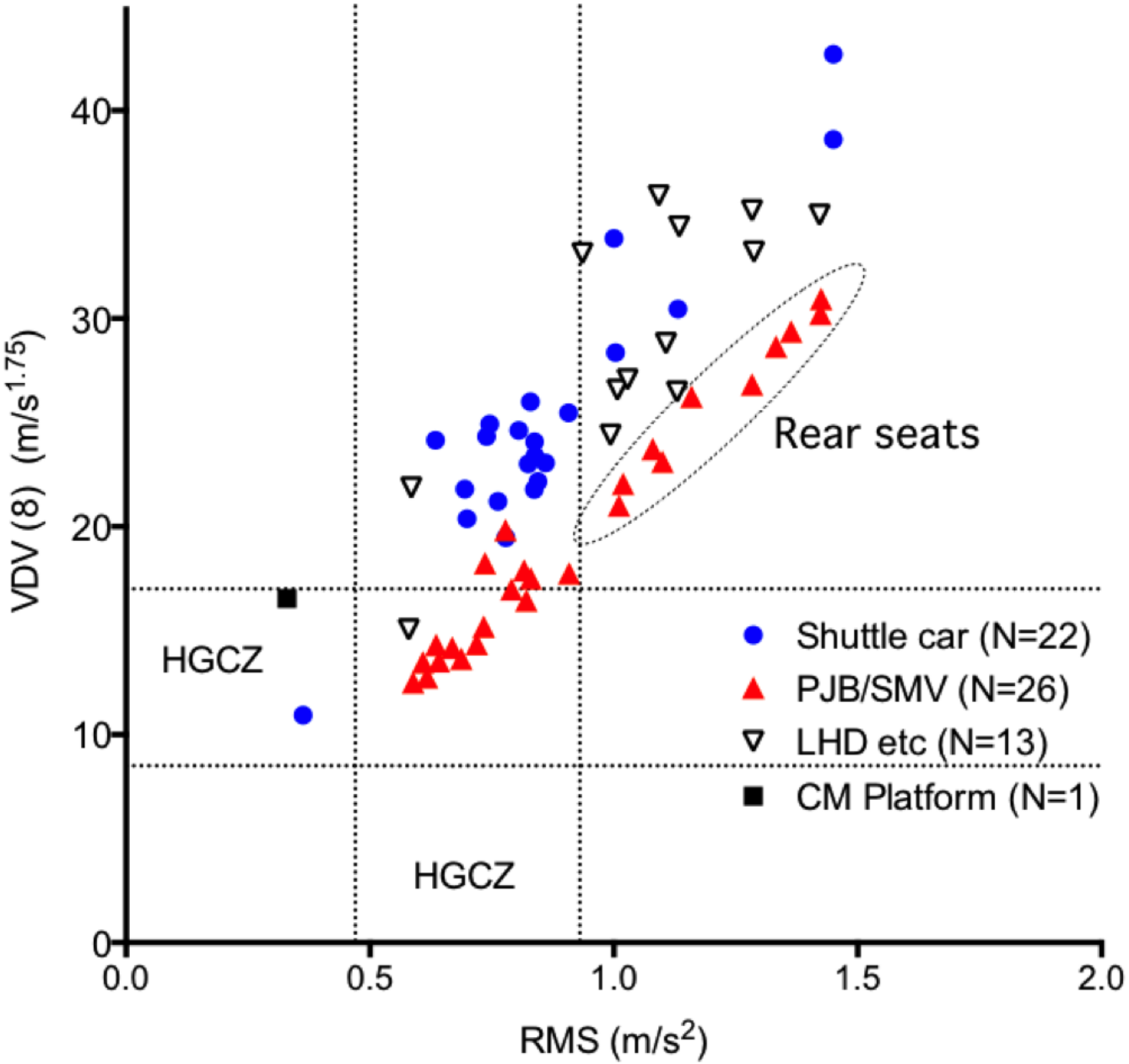


Additional long duration measurements from dozers in operation at a surface coal mine (mean duration 440 minutes)

Further work underway to determine causes of extreme vibration values



Underground Coal Mining Mobile Plant



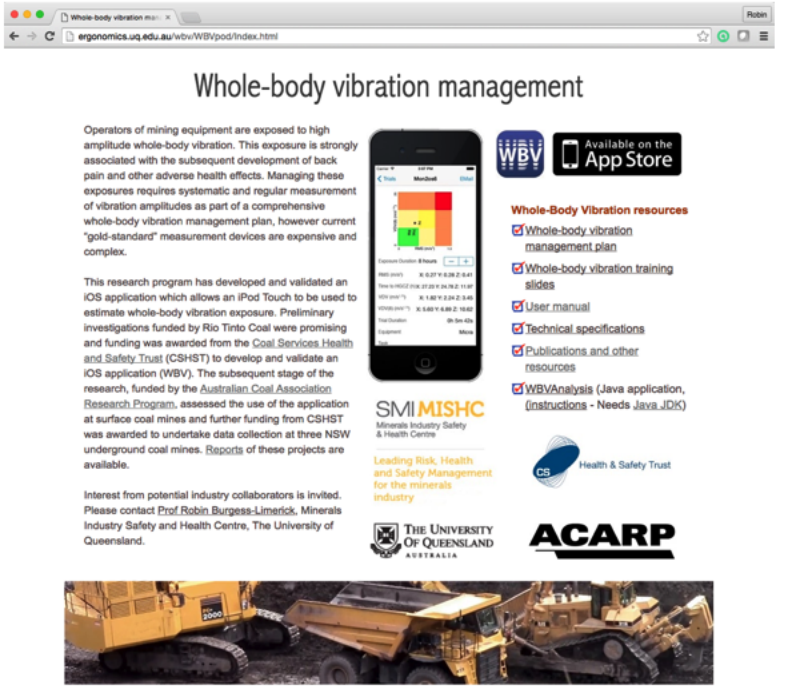
62 duration measurements from equipment in operation at three underground coal mines (mean duration 71 minutes)

Further work underway to examine causes of high vibrations

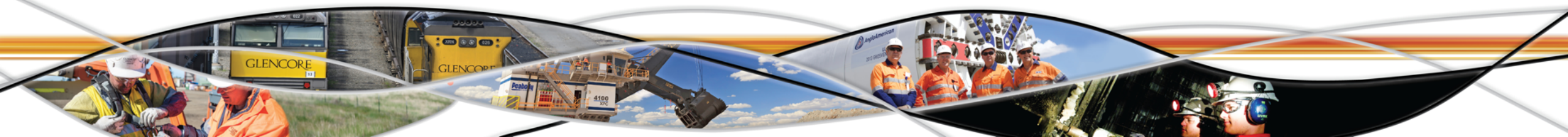
Conclusions

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



ergonomics.uq.edu.au/wbv



Acknowledgments

Health & Safety Trust

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ACARP

Australian Coal Association Research Program project C23022

Project website: ergonomics.uq.edu.au/wbv