Abridged version of original presentation

Whole Body VIBRATION ASSESSMENT

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Types of vibration

- Whole - Body Vibration - WBV
- Hand - Arm Vibration - HAV

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HEALTH EFFECTS

Adverse effects of whole-body vibration

- Evidence is strongest for low back especially when associated with manual handling problems and poor posture
- Complicated by prolonged sitting, poor posture, manual handling and other causes of back pain and injury
- Jolts and jars thought to cause most problems with backs

Effects on the spine

Possible causes of back pain from increased dynamic load on lower back vertebrae

- Reduced disc height
- Increase in radial disc bulge
- Micro fractures in the vertebrae endplates
- Fatigue of lower back muscles

VIBRATION MEASUREMENT & ASSESSMENT

WBV Measurement

Vibration axes

Measurement is taken at the point where vibration enters the body

Acceleration and gravity

$1g = 9.8\ m/s^2$

Passengers have no warning of sudden jolts.

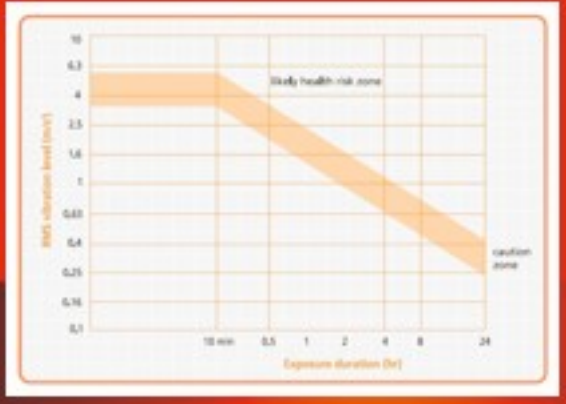
EXPOSURE STANDARDS

Whole-body Vibration – Exposure Standards

- **Australia adopted the International Standard ISO 2631 in 2001 (AS 2670-2001 – Evaluation of human exposure to whole-body vibration)**
- **European Directive – 2002**

Australian Standard AS 2760-2001

Evaluation of human exposure to whole-body vibration – Health Criteria



Australian Standard (ISO Standard)

Basic Evaluation Method – r.m.s **Average Exposure**

Used when vibration exposure is steady state without jolts and jars

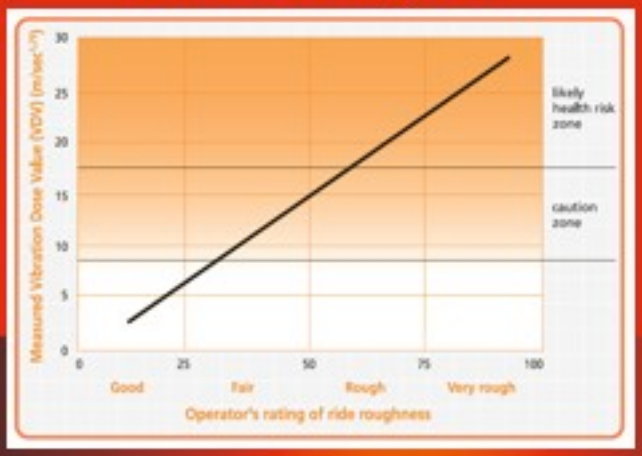
Examples: Drilling
Most dump trucks
Graders
Coal prep plants

Additional Evaluation Methods – VDV **Cumulative Dose**

Used when vibration exposure contains high proportion of shocks or "jolts and jars"

Examples: Dozers
Scrapers
Some light & heavy trucks
Off road vehicles

VDV & Ride roughness



British Standard – BS 6840: 1987

Introduced the Vibration Dose Value (VDV)

- More sensitive to shocks (jolts and jars) than r.m.s method

Action Level – VDV at 15 $m/s^{1.75}$

This level has been found to cause severe discomfort and it was reasoned that levels above this will be accompanied by increased risk of injury.

CONTROL METHODS

Identify vibration sources

A combination of modifying factors is needed to reduce vibration exposures effectively

Suspension seat

- Often poorly adjusted
- Little understanding of seat function by some drivers

Seats

- Air ride suspension seats reduce shocks
- Not always suitable for all applications
- Can increase vibration levels particularly at natural resonance frequency
- Some air ride seats do not allow for intermediate damping settings – soft & hard
- Many drivers do not know how to use the seat properly
- Some find air ride seats too bouncy
- Must be well maintained

Reducing vibration exposure

- Seating
- Roads and surfaces

Roads & work surfaces

Maintaining roads in a satisfactory condition is a common problem in mining.

Sources of vibration exposure
Time-history, z-axis (vertical) for dump truck

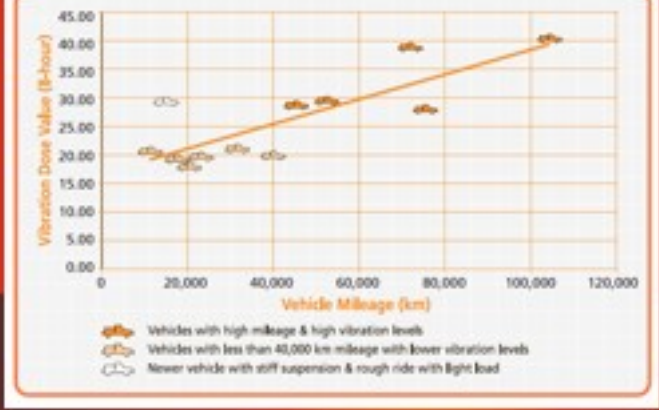
Other benefits of good roads

- Improved travelling times
- Reduced diesel particulate emissions
- Reduced fuel costs
- Less wear & tear on tyres & suspension

Reducing vibration exposure

- Seating
- Roads and surfaces
- **Maintenance & design**

Vehicle condition & maintenance



Overhanging cabin

Hard suspension

Cab layout, design & orientation

- Poor cab design may force drivers into awkward postures, increase their discomfort and reduce the benefits of good seating
- Need adequate head room
- Dozer drivers have to twist and look out the rear window when ripping

The driver's space may be insufficient to allow full adjustment of the seat

Bulldozer operators need to twist in the seat when ripping

Remote control equipment & vehicles

✓ Remove operator from source of vibration

- Increased potential for accidents?
- Equipment wear & maintenance?

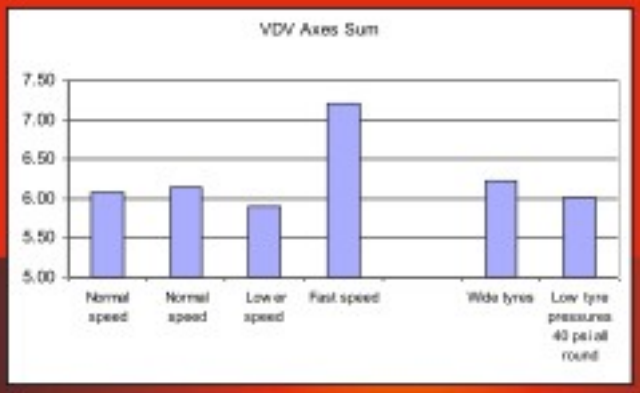
Lighting & visibility

- Hitting potholes which cannot be seen
- Passengers cannot anticipate jolts & jars that can't be seen

Reducing vibration exposure

- Seating
- Roads and surfaces
- Maintenance & design
- Speed

Driving or operating "to conditions"



Speed, driver skills & awareness

Increased speed makes a significant difference to the roughness of the ride

Reducing vibration exposure

- Seating
- Roads and surfaces
- Maintenance & design
- Speed
- **Operator skills**

Training

Training is essential to improve driver skills and to raise awareness.

Obtain feedback from employees on problems and issues.

Typical rough vehicle activity

- Ripping hard rock in a dozer
- Rubber tyred dozer bounce
- Travelling fast in manhaul vehicles
- Scrapers
- Underground mining vehicles mucking out or scaling the roof
- Lateral vibration in a train drivers cabin

Work in a bulldozer is typically rough.

Reducing vibration exposure

- Seating
- Roads and surfaces
- Maintenance & design
- Speed
- Operator skills
- Reducing exposure time

Exposure time

Test No.	Vehicle Type and No.	Work area / Activity	Basic Evaluation (r.m.s.)	
			Time to Caution Zone [hours]	Time to Likely Health Risk Zone [hours]
6	Grader 3	Pit clean up	2.3	9.1
6	Dozer 3	Pit SW clean up	2.8	10.5
5	Dozer 4	Pushing on Western Dump	2.5	9.9
7	Dozer 10	Pit trimming & clean-up	4.7	> 12
2	DT 38	Load/Western Dump	7.8	> 12
15	DT 21	Load/Western Dump	8.1	> 12
1	DT 09	Load/Western Dump	8.8	> 12
3	DT 15	Load/Western Dump	11.3	> 12
14	DT 37	Load/Western Dump	> 12	> 12
13	DT 41	Load/Western Dump	> 12	> 12
12	DT 43	Load/Western Dump	> 12	> 12

Work organisation - Solutions

Drivers need regular breaks out of the seat.

- Rotate operators onto different vehicles or tasks
- Take regular breaks out of the seat/cab
- Consider different ways of doing rough jobs that may reduce vibration

Vibration Control summary

Vibration exposure

Vibration sources:	Modifying factors:
Rough roads	Condition of roads and work surfaces
Vehicle activity	Vehicle activity
Engine vibration	Type and design of vehicle
	Vehicle age and condition, suspension and maintenance
	Seat design, suspension and maintenance
	Cab layout, design and orientation
	Vehicle/Machine speed, driver skills and awareness
	Lighting and visibility
	Task design and work organisation

A combination of modifying factors is needed to reduce vibration exposures effectively.

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Thank you for your attention

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