Department of Industry
Resources & Energy

Mine Safety

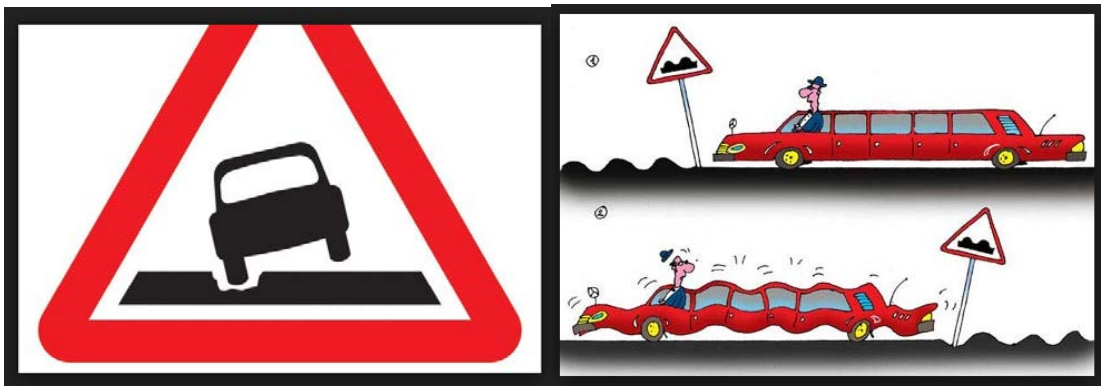
SAFETY BULLETIN

Analysis aims to reduce injuries while travelling underground

BACKGROUND

A data analysis has been conducted of injuries sustained by personnel travelling in rubber tyred vehicles in underground coal mines in NSW. The data set was provided by Coal Services and covered a 10-year period from 2005 to 2014.

The analysis identified 318 separately reported incidents of drivers or passengers who had received injuries ranging from minor sprains or strains through to spinal fractures. These injuries were a result of whole body vibration (WBV) transmitted to the driver or passenger of the vehicle in which they were travelling.



WBV may sometimes simply cause discomfort. However, longer exposures to moderate or intense WBV or large single impacts are often linked to long term issues such as early degeneration of the neck and lower spine, among other problems. Back disorders are believed to arise from damage to the spine and surrounding structures brought about by an accumulation of strains placed on the back over time.

DATA ANALYSIS

The description of the incidents was used to determine information on each of the following (refer to Appendix A)

a) Vehicle type:

Figure 1 highlights the type of vehicle involved. Most injuries occurred in

- load haul dump (LHD) vehicles (43%)
- man transport vehicles (34%).
- shuttle cars (17%).

b) Type of impact or road condition

Figure 2 shows what caused the vehicle to transmit shocks, jolts and jars to the occupant(s) who suffered the injury. This may have been something on the road, the road condition, a sudden stop or a collision of some sort.

- Pot holes account for 40% and bumps in the road accounted for 18%
- General poor road conditions account for 13%
- Objects on the road included rocks, timber, coal, tyres and others.
- Emergency brake application accounted for 5%
- Only 3% of recorded incidents had 'nil' road effects.

c) Driver/passenger distribution – personnel vehicles

Figure 3 shows, for personnel transport vehicles, whether the drivers or passengers were injured.

- Passenger injuries account for 89%
- Driver injuries account for 11%

d) Body part struck and injury type

Figure 4 shows the body part struck as a result of the impact.

- 50% of incidents resulted in a jolt to the injured person. The term jolt was recorded where jarring or no impact with a fixed object occurred.
- 32% of incidents resulted in the person's head being struck.

Figure 5 shows the recorded injury received.

- An injury to the neck was recorded in 50% of all incidents, including -
    - neck muscles/bones (31%),
    - neck and trunk (8%)
    - neck and shoulder (3%)
- Lower back injuries accounted for 26%

e) Yearly trend

Figure 6 shows the number of incidents reported by year. This indicates a decline.

DATA IMPROVEMENTS

Unfortunately the data did not reveal information about a number of key areas of interest useful in targeting WBV control strategies. These include:

a) vehicle speed at the time of incident

b) type of tyres used in the vehicle (pneumatic, solid fill, water fill, run flat insert)

c) tyre hardness/deflection (pressure setting or equivalent)

d) condition (stiffness) of suspension system (for personnel transporters)

e) seat type, orientation and condition at the time of incident

f) location that the injured person was seated at the time of injury

g) mass of load being carried for LHDs and number of passengers for personnel transport vehicles

h) clearance between the seat and vehicle roof

i) whether injured people wore seat belts, or if other seat restraints were used

j) vehicle activity at the time, such as entry to the mine (start of shift) or exit from the mine (end of shift).

In order to understand WBV injuries, information on road conditions, vehicle speeds, vehicle tyres and suspension and vehicle seats is crucial.

RISK CONTROLS FOR WBV FROM VEHICLES

Key risk controls to prevent and mitigate injury from WBV caused by road transport systems include:

a) Fit-for-purpose roads:

- Roads need to be of a suitable standard for both the intended use of the road and the type for vehicles used on that road.
- Reasons for road deterioration should be understood and managed, such as water drainage, tyres which are too hard, excessive vehicle speeds, machinery movements etc.
- Road conditions should be regularly monitored with timely repairs.
- Pot holes, bumps and objects on high speed roads need to be identified and fixed in a timely manner. Unexpected damage or objects on high speed roads have a higher potential to cause greater harm as impact energy is higher.
- Mine management should encourage a culture that reports road damage.
- Erecting signs for hard-to-maintain areas of rough road to remind drivers of the hazards.
- Road standards and specifications should be established for the mine. Consider guidance in MDG 1009 - *Managing road and vehicle operating areas in underground coal mines*.

  Refer to clause 28 “Movement of mobile plant” and schedule 1 “Principal Mining Hazard Management Plans” 4. “Roads or other vehicle operating areas” *Work Health and Safety Regulation 2014.*

b) Appropriate vehicle speeds for the site conditions:

- Vehicle speeds should be established and signposted throughout the mine, taking into consideration road conditions, environment and type of vehicle.
- Vehicle speedometers should be installed and maintained on vehicles including personnel transport vehicles.
- Drivers of personnel transport vehicles should be trained on the effect of WBV including how driving behaviour will affect vehicle passengers.
- Monitoring of vehicle speeds should be done, particularly as vehicles exit the mine.

c) Vehicle tyres and suspension:

- Tyre deflection needs to be appropriate for the type of machine, intended use and road design. Tyres that are too hard (without deflection) transfer more WBV to people in the vehicle and cause significantly more damage to roads, particularly if a small pot hole exists.
- Suspension systems need to be appropriate for the type of vehicle and should be checked at regular maintenance intervals. A failed or stiff shock absorber will increase WBV for all people travelling in the vehicle until the next inspection period.

d) Vehicle seats:

- It is preferable for operator and passenger seats to be forward facing.
- Consider published material in seat design and layout and consult with ergonomic experts.
- Seats need to be maintained and kept in a good condition for use.
- Seat restraints need to be worn.
- There should be provision of sufficient clearance from seat to roof of vehicle.

e) Driver visibility:

- Operator visibility needs to be understood in order to assist in determining allowable vehicle speeds.
- Windscreens need to be kept clean with minimal scratches.

f) WBV monitoring:

- Monitoring of WBV on vehicles should be carried out periodically to verify the overall end result of vehicle design, road condition and operating conditions as would be applied to people travelling on the vehicle. Monitoring should be done in actual conditions such as with loaded transport vehicle and the monitor being located in the rear seat.

RECOMMENDATIONS

Underground coal mines should:

a) Ensure site risk assessments take into consideration WBV on all vehicles operating in the mine and confirm that those risk assessments take into consideration the information and controls in this safety bulletin, including:
    - using technical experts when assessing the risks associated with WBV and setting mine site standards.

- setting vehicle tyres, suspension, visibility and seat standards before use.
- setting road standards and road maintenance practices at the mine.

b) Provide appropriate WBV training and periodic refresher training to all drivers. Consider awareness programs with emphasis on driver skills to reduce jolts and jars caused by excessive speed over known rough sections of road.

c) Take note of driver and passenger feedback on the “roughness” of the ride. It has been shown that this type of feedback can be an accurate indicator of ride quality.

d) Conduct periodic vibration analysis on some or all of the rubber-tyred vehicles starting with the vehicles and seat positions deemed most likely to cause injuries.

e) Should an injury occur, use the questionnaire in Appendix B to provide a detailed report of the situation to assist in determining the root cause.

f) Raise awareness of the need to recognise, report and remove foreign objects on the road and the reporting of pot holes or other significant road damage that should be signposted or barricaded and repaired as soon as possible.

g) Review specifications for new or hired equipment to consider WBV issues. This should include increased head clearance to canopy where roof height allows and an evaluation of pneumatic versus solid fill tyre ride quality.

People with management control of vehicles for use in underground coal mines should review the maintenance practices, condition and effectiveness of:

a) methods to detect and repair faulty suspension systems on personnel transport suspension systems

b) seat belts including their fit-for-purpose design

c) seat suspension systems. These should operate correctly for the range of users.

d) seat condition and padding

e) vehicle lighting and impediments to good visibility such as scratched windscreens, impaired line-of-sight and blind spots.

f) tyres that deflect (are not too hard) and assist in the absorption of energy particularly for personnel transport vehicles.

Designers and manufacturers of vehicles for use in underground coal mines should:

a) consider a short term and long term strategy for the improvement of vehicle ergonomics with respect to WBV issues including seats and seating position, seat belts or alternative restraint devices, head clearance, location and design of displays and controls and visibility from the cab.

b) consider testing their existing product range under specified conditions to identify the baseline vibration of their vehicles when new or rebuilt.

c) include testing for WBV in the ongoing development of their products

d) use tyres and suspensions which provide energy absorption

e) set out means for users to be able to regularly test for suspension system failures.

FURTHER INFORMATION

- Bad Vibrations, A handbook on whole body vibration exposure in mining. By Barbara McPhee, Gary Foster and Airdrie Long.

- Ergonomics for the control of sprains and strains in mining. A handbook compiled by Barbara McPhee.
- *MDG 1009 Managing vehicles and operating areas in underground mines*
- *MDG1 Free steered vehicles*

NOTE: Please ensure all relevant people in your organisation receive a copy of this safety bulletin, and are informed of its content and recommendations. This safety bulletin should be processed in a systematic manner through the mine's information and communication process. It should also be placed on the mine's notice board.

Signed

Gary Parker
Chief Inspector of Mines
Appointed pursuant to Work Health & Safety (Mines) Act 2013

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APPENDIX A

Figure 1- Vehicle type (318 reported incidents)

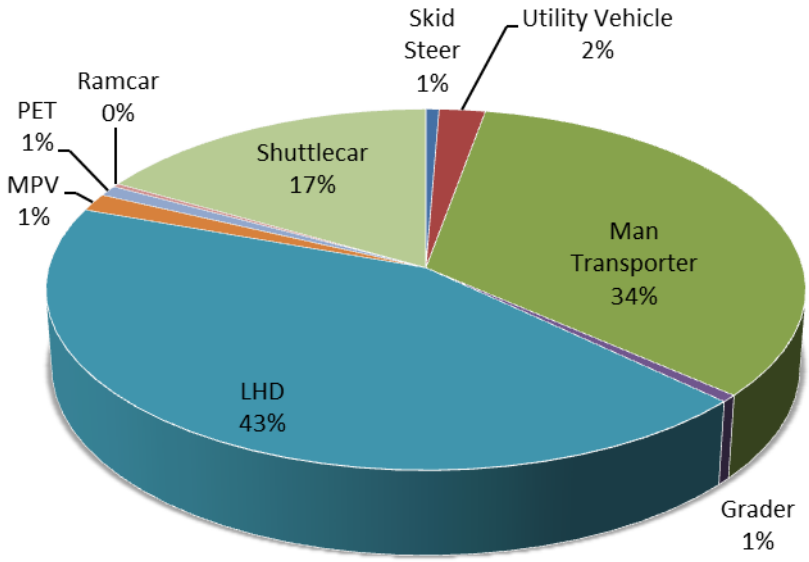

Figure 2 –Type of impact or road condition (318 reported incidents)

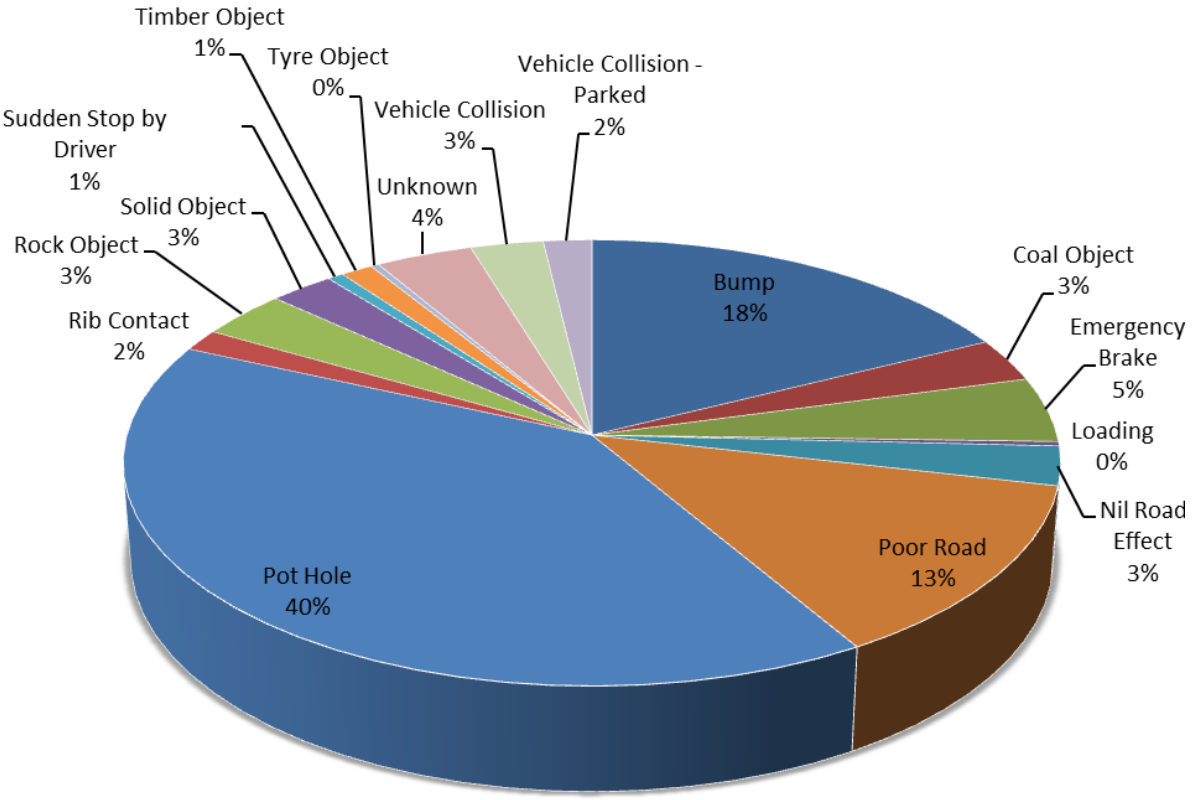

Figure 3 – Driver/passenger distribution – personnel vehicles (318 reported incidents)

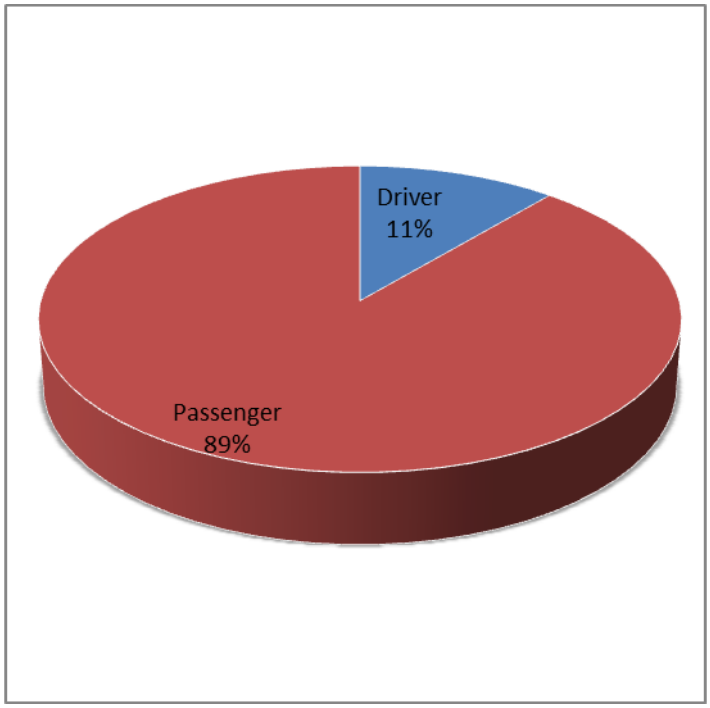

Figure 4 – Body parts struck (318 reported incidents)

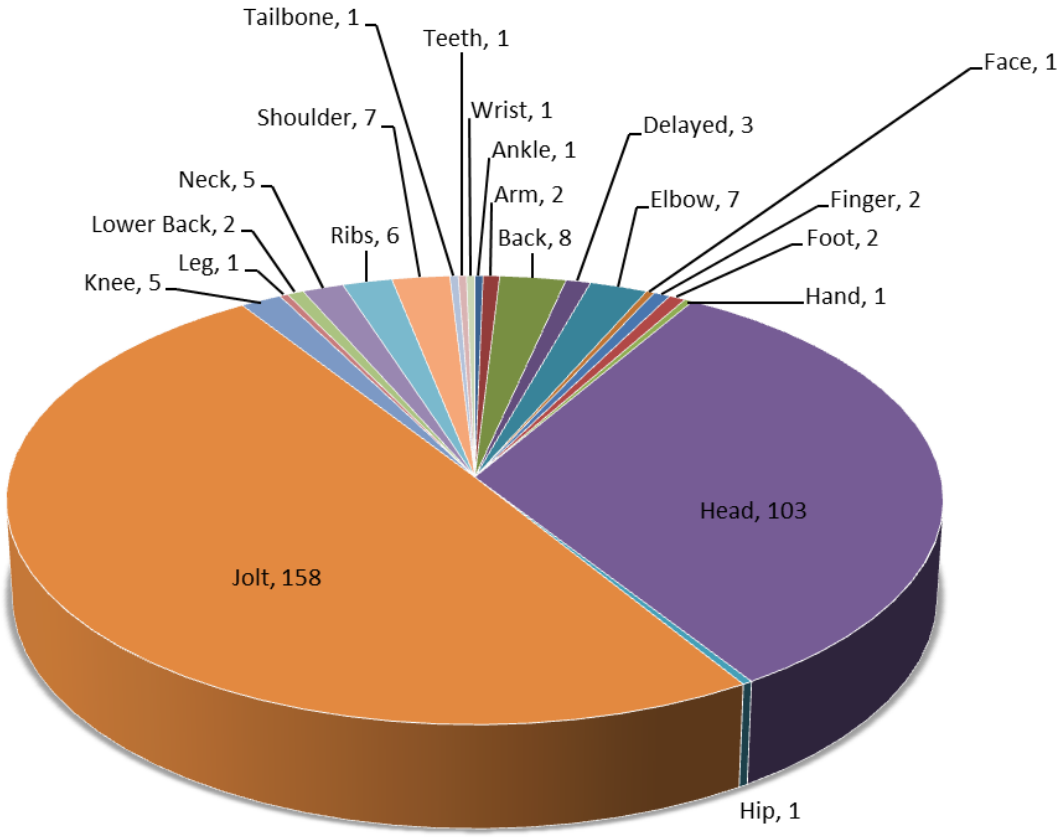

Figure 5 – Recorded injury type (318 reported incidents)

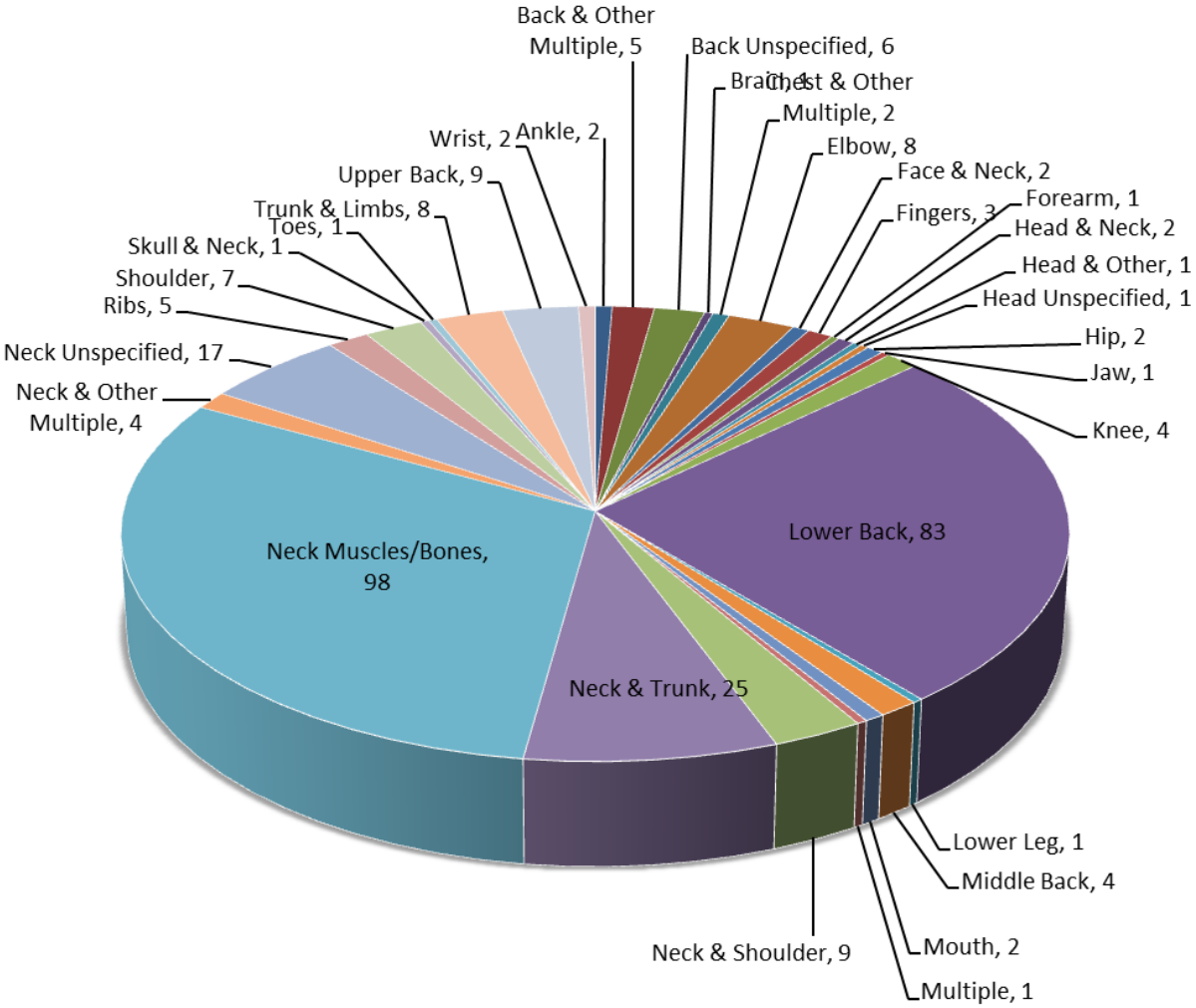

Figure 6 – Number of incidents recorded each year