PREVENTING INJURIES

Analysis of injuries highlights high priority hazards associated with underground coal mining equipment.

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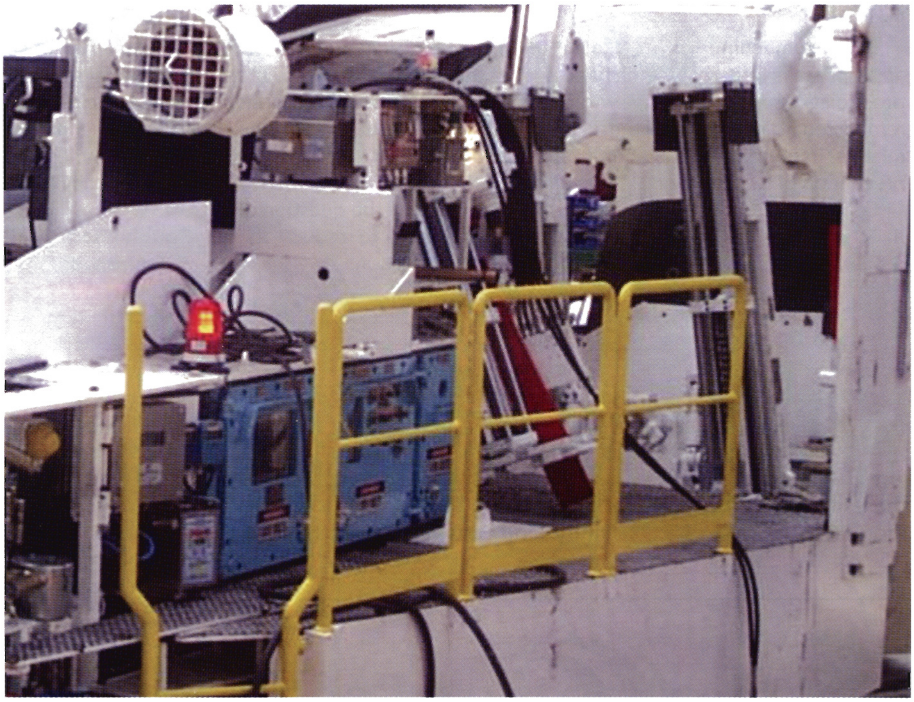


Research has shown fitting handrails to continuous miners is justified to reduce injuries from falls.

In 2004, there were 646 underground coal mines in the USA employing 37,445 miners. These mines reported 3556 injuries to MSHA that year — 17% were associated with bolting machines (593 injuries), 8% with continuous miners (283 injuries), and 4% each with Scoop/LHD (151 injuries), shuttle cars (134 injuries), and personnel transport (145 injuries).

The use of the frequency of reported injuries for the prioritization of risk control strategies has limitations because of the tendency to underestimate the importance of relatively rare but high-consequence events.

Injury reports also underestimate the contribution of risk factors such as whole body vibration, which have a long-term cumulative contribution to an elevated risk of injury. However, taking these limitations into consideration, the results of the injury narrative analysis suggest the following hazards as the highest priority for elimination or control:

- rock falling from supported roof
- inadvertent or incorrect operation of bolting controls
- handling continuous miner cable
- collisions while driving LHD/Scoop, shuttle cars and personnel transport
- rough road while driving or traveling in LHD/Scoop, SC & PT

Rock falling from supported roof

The most common injury mechanism associated with bolting machines is rock falling from supported roof, which caused 208 bolting machine injuries in 2004 (33% of injuries associated with bolting machines).

This type of event also accounted for 59 injuries associated with the operation of continuous miners in 2004 (21% of injuries associated with continuous miner operation).

An inspection of all 3556 injury narratives suggests that 13% of all injuries reported in 2004 were caused by rock or coal falling from supported roof (total of 477 injuries).

The number of injuries as a consequence of coal or rock falling from supported roof is reduced from the 650 reported as the annual average from 1995 to 2001, suggesting that there has been a reduction in overall injuries of this type in recent years.

This is likely in part to be a consequence of the introduction of roof screening in some US mines, which has been demonstrated to virtually eliminate injuries of this type.

While screening is undoubtedly an effective control, low seam heights make screen installation difficult. Additional hazards are also introduced with the use of roof and rib screen, particularly additional risks of musculoskeletal injury associated with handling screen, as well a potential exposure to rock and roof fall while setting the screen.

Improvements in the handling of screen are also being developed, which have potential for further reducing the risk associated with handling and placing screen.

The importance of preventing rock fall injuries cannot be overstated. Where low seam heights make screening with steel mesh difficult, it may be necessary to develop alternative means of controlling skin failure such as the use of shotcrete or other membrane. Controlling skin failure, whether through screening or other means, would prevent nearly 500 injuries per year or 13% of all injuries in US underground coal mines.

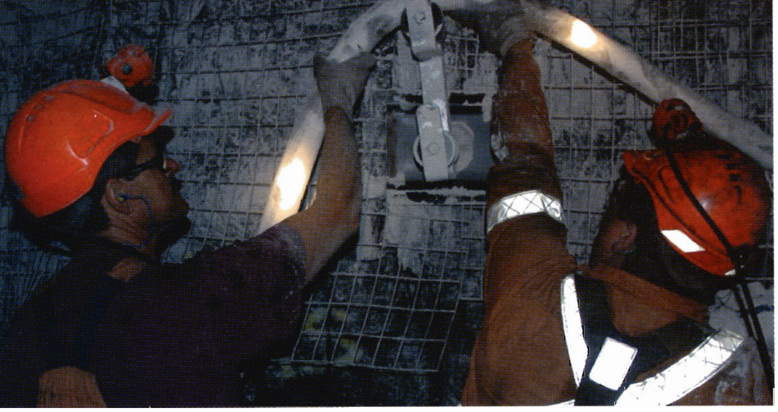
Inadvertent or incorrect operation of bolting controls

Injuries involving a part of the body being struck by, or caught between, when adjusting, drilling or bolting work was carried out, occurred with relatively high frequency. Relatively minor injuries occurring as a consequence of being struck by falling drill steels, bolts, or plates accounted for many of the "struck by" cases.

More serious injuries that occurred were associated with unintended consequences of the operation of bolting controls, causing operators or another person to be struck by the boom, caught between the bolting machine and the rib, or caught in pinch points on the machine.

The control operation was sometimes unintentional, typically caused by bumping a control with self-rescuer or battery, or a control being struck by a falling object. Injuries caused by intentional control operation may be further divided into cases where: (i) the wrong control was operated; (ii) the correct control was operated in the wrong direction; or (iii) operating of the intended control in the intended direction while the injured employee (either the operator or another person) was in a position of danger.

Bolting machine controls require guarding to prevent inadvertent operation (while still allowing access for intentional operation). Improvements to bolting machine design are required to guard pinch points and provide interlocks to reduce the probability and consequences of intentional or unintentional



Handling continuous miner cable can cause injuries.

control operation whilst the operator or other person is in a hazardous location.

Bolting machine controls also require standardization to an appropriate layout (including shape and length coding) to reduce the probability of operation of the wrong control, although open questions remain regarding whether control layouts should be mirrored, and the relative importance of shape, location and length coding for the prevention of "wrong control" type errors.

Control standardization must also consider carefully the question of directional control-response compatibility principles to reduce the probability of operation of controls in the wrong direction.

Cable Handling

Handling cable accounted for 76 of the 283 continuous miner related injuries (27%).

The severity of injuries associated with handling cable varies from relatively minor shoulder strains to serious back injuries.

Whilst the cumulative nature of most musculoskeletal injuries implies that other manual tasks are likely to have also contributed to these injuries, there is no doubt that handling continuous miner cable represents a high risk of injury and this is consistent with biomechanical analysis of the task. Engineering controls are required to eliminate or reduce manual cable handling.

Vehicle collisions

Whilst vehicle collisions represented a relatively small proportion (15%) of the injuries associated with Scoop/LHD, shuttle car and transport, the consequences of collisions are frequently severe and include fatalities.

This figure is also double the proportion of "collision" related injuries for these vehicles found in recent Australian data. The probability of vehicle collisions is increased considerably by the restricted visibility inherent in LHD and shuttle cars, and this is likely exacerbated by the low seam heights.

Recommendations for LHD redesign arising from the research include raising the sitting position where possible and cab redesign to remove visual obstructions.

Physical separation of pedestrians and vehicles as far as practicable, and vehicle-mounted proximity sensors and cap lamp battery mounted emitters may also be beneficial in preventing potentially serious injuries. Examples of proximity detection systems include that developed by NIOSH.

Rough Road

Injuries associated with driving or traveling in a vehicle that encounters a pot hole or other roadway abnormality accounted for 20% of injuries associated with scoop/LHD, shuttle car or transport.

Improved roadways would be an effective means of preventing injuries of this type. Provision of vehicle suspension and improved seating also have the potential to reduce these acute injuries. These improvements will also reduce exposure to high amplitude whole body vibration which is strongly associated with the development of back pain through cumulative mechanisms.

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