

Causes of fall fatalities at surface mines

by Mahiya F. Nasarwanji

Surface mines can be hazardous places to work, with approximately 5,800 nonfatal injuries a year (MSHA, 2006-2015). Slips and falls are a major contributor to these nonfatal injuries, second only to material handling injuries. Slips and falls account for approximately 26 percent of nonfatal injuries, leading to approximately 64,000 lost work days a year (MSHA, 2006-2015). Adequate attention has not been placed on slips and falls and they continue to be a significant cause of mining fatalities. In fact, 55 (11 percent) of the 487 fatal incidents reported by the U.S. Mine Safety and Health Administration (MSHA) between 2006 and 2015 were due to slips and falls at surface mines (MSHA, 2006-2015).

Most mines have programs to prevent slips and falls. However, due to the high prevalence of slip and fall injuries and fatalities, there is a need to take a closer look at what causes fatal slip and fall incidents. A better understanding of these incidents can help companies prevent future fatalities. To that end, the National Institute for Occupational Safety and Health (NIOSH) conducted a review of slip and fall fatalities to better understand their causes.

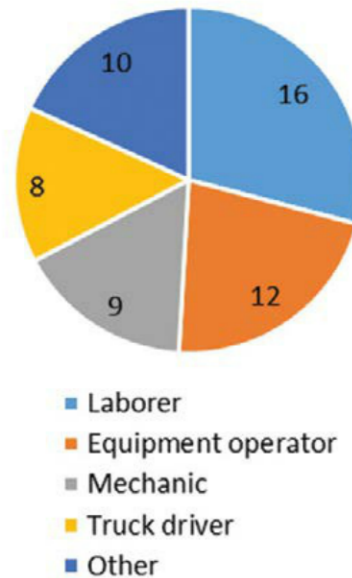
Using MSHA data to determine the causes of fatal slips and falls

MSHA provides detailed accident investigation reports for each fatality. These reports include information on the chain of events that led to the fatality and measures to prevent a future occurrence. NIOSH analyzed the MSHA accident investigation reports for the 55 fatalities associated with slips and falls between 2006 and 2015. The objective was to identify trends and commonalities that can be used by miners and mining companies to prevent slips and falls.

First, all of the MSHA fatal accident investigation reports between 2006 and 2015 were reviewed to identify those that involved a slip or fall. Next, two researchers independently read each slip and fall fatality report to identify the primary job tasks of the fatally injured miner, the tasks being performed at the time of injury, the cause of the fatality and the factors, that if controlled, may have prevented the fatality (Nasarwanji, 2016). Finally, the same two researchers compared and combined their findings to ensure they were consistent and reliable.

Figure 1

Occupations involved in 55 fatalities occurring between 2006 and 2015.



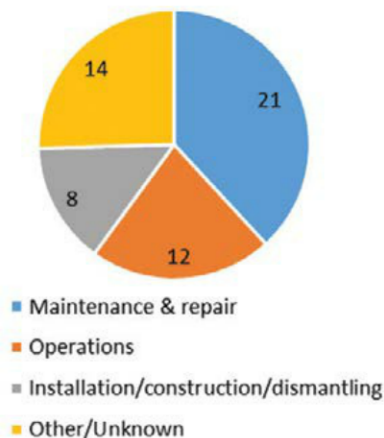
The cause of the fatality that was determined by MSHA as being the primary — and secondary when available — cause of injury were examined. The primary cause of injury was defined as the event immediately preceding the fatality (Nasarwanji, 2016). For example, if a miner died because he/she fell off of a ladder when the ladder shook because a pipe broke and struck the ladder, then the primary cause of the fatality was falling off of the ladder. The secondary cause was defined as the event that immediately preceded the primary cause. In this example, the ladder shaking would be the secondary cause.

Contributing factors that may have prevented the injury were anything that would have kept any one event within the chain of events from occurring (Nasarwanji, 2016). These factors can be controlled by the miner or the mining company. In the previous example, the broken pipe led to the ladder shaking. In that case, adequate inspection, maintenance and repair may have prevented the equipment failure. In addition, the fatality may have been prevented if the miner had been wearing a personal fall arrest system. As this example

Mahiya F. Nasarwanji is with Pittsburgh Mining Research Division, National Institute for Occupational Safety and Health, e-mail: MNasarwanji@cdc.gov.

Figure 2

Tasks being performed when 55 fatalities occurred between 2006 and 2015.



demonstrates, in most cases, there are several contributing factors that can be controlled to prevent a fatality.

Who was injured?

NIOSH's analysis was able to determine the job types and work tasks commonly associated with slip and fall fatalities. As Fig. 1 shows, the most common victims of fatal slips or falls were laborers (30 percent), equipment operators (22 percent), mechanics/maintenance men (16 percent) and truck drivers (15 percent). The largest proportion of fatalities (38 percent) occurred when miners were performing maintenance and repair tasks (Fig. 2). Daily operations (22 percent) and installation/construction/dismantling (15 percent) were also tasks associated with fatal slips or falls.

Maintenance, construction and dismantling are especially hazardous due to their dynamic nature (Reardon et al., 2014). During these types of activities, the work environment can change rapidly and continuously. If miners are not made aware of these changes or the potential for these changes, it can be hazardous. For example, if a piece of floor grating is removed for replacement, even for a few minutes, without adequate signage or barriers, other miners may not be aware of the floor opening and fall through it (Fig. 3). Likewise, when dismantling there are times when equipment and parts may be left unsupported or inadequately supported. Miners are then placed at risk due to unexpected movement of equipment.

What caused the fatalities?

Fall from height was the primary cause of nearly half (49 percent) of the fatalities.

Working at heights is often required as part of daily duties, but, as the data show, can be hazardous if adequate precautions are not taken. A further 18 percent of the fatalities were due to a fall from stairs or ladders. Other causes of fatalities were falling into water (11 percent), from equipment (7 percent), into material (5 percent) or from a truck or trailer (5 percent). Failure of equipment or ground (15 percent), falling through an opening (9 percent), slips (9 percent) and unexpected movement of equipment or ground (7 percent) were some of the secondary causes identified.

What could have prevented the fatalities?

Properly using a personal fall arrest system — when it was appropriate for the circumstances and with correct tie-offs — could have prevented one third (33 percent) of the fatalities. Although personal protective equipment (PPE) should be the last line of defense, if other controls are not employed, using a personal fall arrest system appropriately can save lives.

Fixing broken or damaged equipment, using equipment as designed, and not modifying equipment beyond its intended purpose could have prevented an additional 13 percent of the fatalities. Establishing and following safe operating procedures (13 percent), providing barriers where necessary to prevent inadvertent contact (8 percent), and locking out, tagging out and blocking equipment (8 percent) could have also prevented fatalities.

What can you do to protect yourself?

Based on the analysis, there are two areas where miners can help protect themselves from slips and falls.

Pay special attention when performing or working around maintenance and repair activities and during installation, construction and dismantling. This is important because during these activities the work environment is different from normal operations, can change often and can change very quickly. In addition, the usual safety features such as barriers and guards may be removed or disabled. Remember to perform a hazard assessment prior to beginning work and keep vigilant for new hazards while working. Anticipate potential dangers such as moving parts and floor openings and secure necessary tools and safety measures to prevent these hazards.

Correctly use appropriate personal fall arrest systems when needed. When working at

any height where there is a likelihood of falling, it is always recommended to err on the side of caution and use a personal fall arrest system. Put simply, using a personal fall arrest system can save your life. It is also important to use a personal fall arrest system that is designed for you (taking into account your weight and height) and has been recently inspected. Finally, don't forget to tie-off appropriately.

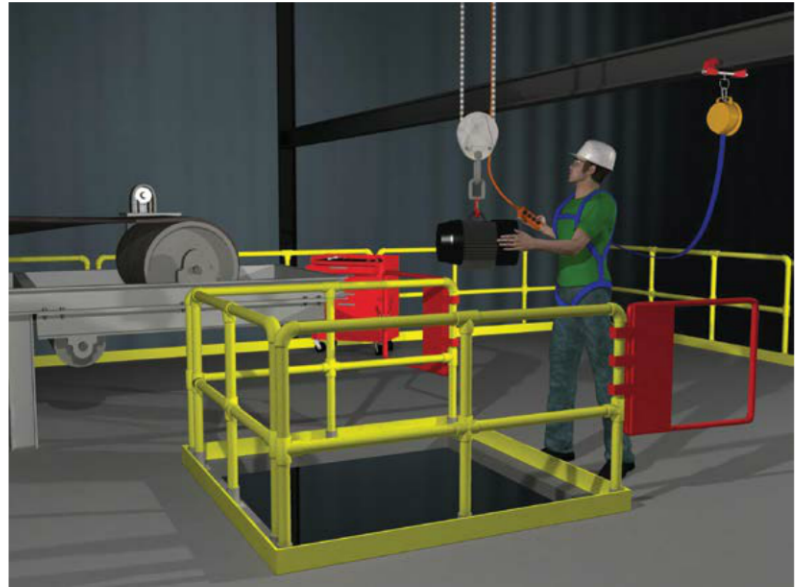
What can mining companies do to protect miners?

Based on the analysis, companies can help protect miners from potentially fatal slips and falls by following the recommendations below. Each recommendation is aligned with the hierarchy of hazard controls from the most effective to the least effective (Fig. 4).

Design equipment to prevent or minimize hazards when working at height. The best way to eliminate falls from heights is to improve the design of the work environment. Truck loadout areas are an example where an appropriately designed access system to close hatches/tarps can eliminate some of the hazards associated with working at heights. Truck loadout systems can be designed to include an elevated guarded platform to close hatches on different types of trucks, adequate space and markers to align the truck, and a safe means of access to the elevated platform. In addition, when purchasing new

Figure 3

Example of maintenance work being performed around a well-designed floor opening with adequate fall protection. Note the permanent barriers, gate to access the opening, toeboards and the safe working practice, including the use of a personal fall arrest system.

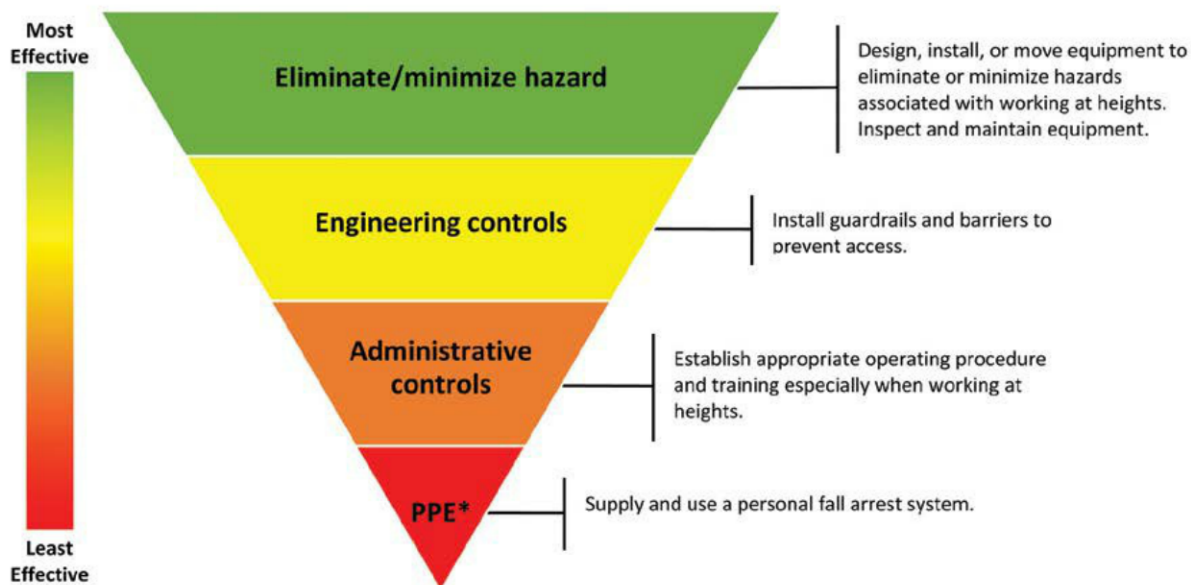


equipment, look for features that eliminate the need to work at heights or minimize hazards associated with working at heights.

Inspect and maintain equipment. Actively look for defects and fix damaged and improperly modified equipment. A number of slip and fall fatalities were due to failure of a piece of equipment, improperly used equipment or modifications. Regular maintenance and

Figure 4

Hierarchy of hazard controls to prevent fall fatalities with examples (*Personal Protective Equipment). Source, NIOSH.



inspection of equipment can help to identify hazardous working conditions and prevent failures.

Install barriers to prevent access to hazardous areas, especially around unguarded floor openings. There are numerous scenarios where barriers can be added. During maintenance activities when railings and floor surface may be removed, additional barriers should be added to prevent falls. During housekeeping, debris could cover floor surfaces that are not designed to support loads, such as skylights and temporary coverings; in these cases, barriers should also be used. It is preferable to have permanent barriers installed, but if this is not possible, use temporary barriers that are clearly visible, sized to prevent access and accompanied by signage that identifies the hazard.

Establish and use safe operating procedures and provide adequate training. The analysis shows that having safe operating procedures documented and ensuring that they are followed can prevent fatalities. For example, during maintenance, construction and dismantling, procedures should be in place to not only lock out and tag out equipment, but also to block any object that could potentially break loose or move.

Supply personal fall arrest systems. Mines should supply appropriate harnesses fitted to the miner's height and weight, designed for the task, and located close to where they are needed. Substantial tie-off points should be designed into

the work environment and clearly labeled to foster their use, and miners should be trained in using fall protection equipment to ensure proper use (MSHA, 2012 and NIOSH, 2016). ■

Disclaimer

The findings and conclusions in this paper are those of the author and do not necessarily represent the views of the National Institute for Occupational Safety and Health (NIOSH). Mention of any company or product does not constitute endorsement by NIOSH.

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