

You Can't Shoot What You Can't See

The Importance of Lighting in an Underground Environment

By Joe Derochie

We know that better lighting reduces accidents, increases production, and improves the quality of in-place shotcrete underground—so why it is still common to see an underground shotcrete crew struggling to illuminate the rock face using little more than the light from a cap lamp? From a safety standpoint alone, it has been well documented that good lighting reduces highway accidents, factory and warehouse accidents, and even accidents in the home. So, it isn't much of a stretch to assume that proper lighting is even more important in an underground environment.

After Thomas Edison patented the first practical incandescent lamp in 1879, industrial lighting systems evolved rapidly, and improvements in underground lighting technology have resulted in

greater safety, increased production, and enhanced worker comfort. In the mining and tunneling industries, however, the adoption of these improvements lagged behind others for a number of reasons—the primary reason being the aggressive and hazardous environment, which required the development of special, expensive hardware and circuitry. Even this technology was slow in coming and didn't start to take off until mine and tunnel lighting was required by law.

Objectives of Lighting in Mining and Tunneling Operations

Statistics show that workplaces in the mining and tunneling industries are among the most



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hazardous, and personnel who work in these industries should therefore benefit the most from lighting that fully uses modern technology. There are a number of specific lighting objectives that should be targeted when working in an underground construction environment, including:

1. **Increase the visibility of hazards**—Because of the low luminance levels and poor contrast, particularly in underground mines, hazards are often difficult to identify. Examples of these hazards include frayed or cut cables, uneven ground, shotcrete material and air hoses, rock debris, and other difficult-to-identify objects. The primary goal of lighting in a mining or tunneling environment is to increase the visibility of these objects so that injuries caused by these undetected hazards are reduced.
2. **Increase awareness of hazards in the peripheral field of vision**—With a narrow-beamed cap lamp alone, the movement of personnel and mobile equipment can be difficult to detect when it occurs in a shotcrete nozzleman's (or shotcrete crew member's) peripheral field of vision. While movement can be detected if it occurs within the localized main beam of the cap lamp, members of the shotcrete crew should also be able to detect even subtle movement anywhere in their normal field of vision.
3. **Improve vision for the shotcrete nozzleman**—It's difficult to shoot what you can't see. A

shotcrete nozzleman must have a clear view of the rock face when applying shotcrete to ensure that the material is being applied at the correct angle, at the correct distance from the rock face, and at the specified thickness. With the dry-mix process, the nozzleman also controls the water-cementitious material ratio (w/cm) and must therefore also be able to clearly see the consistency of the material as it impacts a surface. Without a clear view of the shotcrete consistency, the nozzleman will most likely be faced with dramatically increased rebound levels caused by “too-dry consistencies” or increased sloughing caused by “too-wet consistencies.” Remote shotcreting, usually conducted from mobile shotcrete spraying units, is always supplied with lighting systems that are designed to address the minimum needs of the shotcrete crew. While most of these systems provide enough lighting to illuminate a heading, secondary, portable lighting should also be used to enhance overall workplace visibility and reduce shadowing. In many underground projects, shotcrete is also applied through welded wire mesh (a secondary ground support)—the ends of which are often overlapped. In these cases, the nozzleman must be able to detect these areas and react accordingly so that voids are not produced behind the overlapping screen.



Proper lighting will reduce workplace accidents, but it is particularly important in an underground environment

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- 4. Increase worker comfort and reduce fatigue—** Studies have shown that working in poorly lit environments causes worker fatigue, reduces comfort, and adversely affects morale. Improved lighting offers considerable improvement in the psychological aspects of the underground workplace and will produce corresponding improvements in related areas, such as productivity and absenteeism.

New Lighting Technology

Today, the mining and tunneling industries are supported by a lighting industry whose technological advances improve both cost-effectiveness and performance. Even cap lamps are lighter and more reliable than those used just a decade ago. Light-emitting diode (LED) technology offers longer operating cycles, and ultra-lightweight lithium-ion batteries can keep cap lamps illuminating for the longest possible underground shifts.

New technology (LED and others) has also been adapted by companies who supply portable lighting fixtures that are commonly used by underground shotcrete crews. The shotcrete process is not static and crews are expected to travel throughout an underground excavation. This movement necessitates the constant movement of light fixtures and often results in damage to the portable lighting systems. The new LED lighting systems are usually more durable and longer-lasting.

Proper Maintenance

Maintenance plays an important role in any successful shotcrete operation, but special attention should be paid to the maintenance of the lighting system, especially when shotcreting in an underground environment. Lenses on portable lighting systems should be monitored for a buildup of rebound and overspray and should be cleaned when necessary. High temperatures will accelerate the cement hydration process, making it difficult to remove hardened material from the lens if the cleaning is delayed. Shotcrete crews should always carry extra bulbs or lenses to quickly replace those that are damaged from the rugged underground conditions. Wires or electrical cords should also be monitored for damage, especially in wet environments, where the danger of electrical shock can create an unsafe situation.

Conclusions

There are many factors that contribute to a safe and successful underground shotcrete operation. One of the most critical is sufficient lighting. Working with insufficient lighting can be like sending a blindfolded shotcrete crew underground. The quality of shotcrete would be suspect (to say the least) and safety would no doubt be compromised.

References

Underground Coal Mine Lighting Handbook, W. H. Lewis, ed., United States Department of the Interior, Bureau of Mines, Washington, DC, 1986, 100 pp.



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