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The Saturn LED Area Light Provides Improved Illumination for Greater Roof Bolter Safety

Summary

Researchers at the National Institute for Occupational Safety and Health (NIOSH) have developed the Saturn LED area light that significantly improves illumination for roof bolting machines in underground mines, thereby enhancing safety by reducing injuries to miners. Providing better illumination underground improves a miner's ability to see and to avoid potential hazards in the mine. Results from NIOSH's scientific testing confirm that the Saturn light enables major improvements in trip hazard detection and reduced glare when compared to the existing roof bolter lighting. The Saturn area light design is now freely available for commercialization.

By John J. Sammarco

Background

Providing adequate lighting for miners to work safely is a significant challenge given that underground mines are one of the most difficult environments to illuminate [Rea 2000]. Although a trend of increasing mine worker safety is evident, mining equipment-related fatalities and injuries are still at unacceptable levels. As an example,

during 2004 to 2013, roof bolter operators experienced 16 fatalities and 3,411 nonfatal lost-time injuries, accounting for 64.7% of injuries at underground coal mines [Sammarco et al. 2016].

Historically, lighting a roof bolter has been challenging given the machine's size, limited space for mounting lighting, low contrast levels, and excessive glare due to the workers' close proximity to the machine lighting. To address these challenges, NIOSH researchers developed the Saturn LED area light with the main objectives of reducing

glare and increasing floor illumination to improve the ability of miners to see floor tripping hazards. A secondary objective was to reduce the size of the lighting to give more flexibility for mounting the lighting on roof bolters—thus, new mounting locations could potentially provide better illumination of hazards. The Saturn LED area light (Figure 1) takes up only one-third the volume compared to existing lights used on roof bolters, and it has a useful life of about 30,000 hours in contrast to the existing



Figure 1: The small size of the Saturn LED area light enables greater flexibility in machine mounting locations.

Photo by NIOSH

lighting life of about 8,000 hours from traditional lighting. The longevity of the Saturn reduces the likelihood of maintenance-related injuries and reduces maintenance costs.

Approach

NIOSH conducted a comparative study of glare and visual performance for the detection of trip hazards using the traditional roof bolter lighting and the Saturn LED area light. A walk-thru roof bolter was used for the study. The roof bolter light sources were compact fluorescent lamps shrouded by yellowish-orange polycarbonate globes intended to reduce glare and to protect the lamps. The Saturn light used an array of 12 cool-white LEDs that provide lighting similar to natural daylight. Thirty people participated in the study, with ten people in each of the three age groups: young 18–25 yrs. old; middle 40–50 yrs. old; oldest > 50 yrs. old. The age group from 26 to 39 years was not included because there are generally minimal changes in vision among those ages [Blanco et al., 2005]. Age is an important factor because visual abilities generally decrease as age increases.

The well-established De Boer 9-level rating scale [De Boer 1967] was used as a qualitative method for determining discomfort glare. Visual performance was quantified as the reaction time to detect a trip hazard, where visual performance improves as the detection time decreases.

Findings

The unpublished results of the study indicated significant reductions of discomfort glare and major improvements in detecting trip hazards when using the Saturn LED area light (Figure 2). Discomfort glare was improved up to three levels (from level 5 to 8). The De Boer 9-level rating scale for discomfort glare ranges between level 9 (just noticeable) and level 1 (unbearable). The mean trip hazard detection time for the oldest age group (> 50 yrs. old) was improved 58% with the Saturn LED area light.

Notable Achievement

The NIOSH research team for the Saturn LED area light won the 2017 NIOSH Bullard-Sherwood Research-to-Practice Award, which recognizes outstanding efforts by scientists and their partners in applying occupational safety and health research to prevent work-related injury, illness, and death.



Figure 2: *The existing illumination provided by traditional lighting for a roof bolter (left). The improved illumination provided by the NIOSH-developed Saturn LED area light (right).*

Photos by J.H. Fletcher & Co.

Availability

The NIOSH Saturn LED area light design documentation package can be downloaded at <https://www.cdc.gov/niosh/mining/content/saturnarealight.html>.

Acknowledgment

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References

- Blanco M, Hankey J, and Dingus T [2005]. [Phase II-Study 2: Visual performance during nighttime driving in rain](#). In Enhanced Night Visibility Series. U.S. Department of Transportation.
- De Boer JB [1967]. Visual perception in road traffic and the field of vision of the motorist. In Public Lighting, JB De Boer, ed. Eindhoven, The Netherlands: Philips Tech. Library.
- Rea MS (ed.) [2000]. [IESNA lighting handbook: reference and application, 9th ed.](#) New York, NY: Illuminating Engineering Society of North America.
- Sammarco JJ, Podlesny A, Rubinstein E, Demich B [2016]. [An analysis of roof bolter fatalities and injuries in U.S. mining](#). Transactions of the Society for Mining, Metallurgy, & Exploration. 340(1):11–20.

For More Information

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