CDC NIOSH Workplace Safety and Health

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Bit Isolator Reduces Drilling Noise in Underground Coal Mines

Objective

To develop an engineering noise control that reduces roof bolting machine (RBM) operators' exposure to noise in underground coal mines, thereby decreasing the risk of noise-induced hearing loss (NIHL) in RBM operators and other workers in close proximity to RBMs.

Background

NIHL is one of the most widespread occupational illnesses in the United States. Studies conducted by the National Institute for Occupational Safety and Health (NIOSH) indicate that 70%–90% of miners have NIHL significant enough to be classified as a hearing disability. Mine Safety and Health Administration (MSHA) studies indicate that RBM operators are among the miners who are most frequently overexposed to noise. To reduce the noise exposures of RBM operators, noise controls must be developed.

NIOSH research has shown that the drilling process itself, rather than the hydraulics and electric motors, is the major contributor to the noise generated during the roof bolting operation. NIOSH field studies have shown that the drilling portion of the roof bolting cycle is the primary source of an RBM operator's noise exposure. Figure 1 shows results from a beamforming analysis that NIOSH conducted during laboratory replication of RBM operation. Beamforming is a technique that uses a large array of microphones to locate noise sources. The contour plot in Figure 1 shows that the top of the drill steel is the dominant source of drilling noise, and the chuck is a secondary contributor to drilling noise (both indicated by the light yellow color bands). The noise radiated from the drill steel is a result of vibration generated at the bit-rock interface that is transmitted from the bit to the drill steel. Because the drill steel generates more noise than the other noise sources and the operator works close to it, the drill steel is the primary source of the operator's noise exposure.

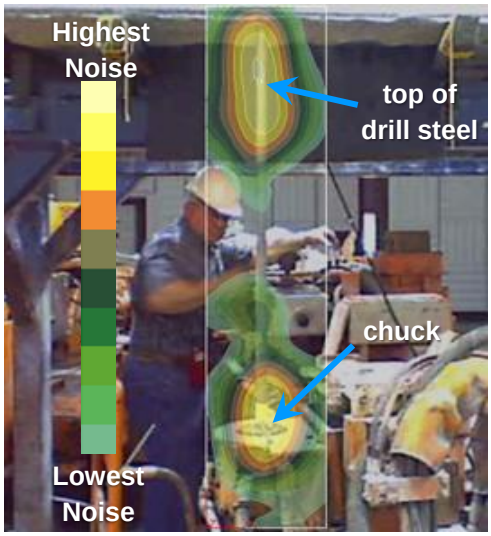

Figure 1. NIOSH's beamforming analysis showing dominant noise sources at the top of the drill steel and the drill chuck.

Technical Approach

The preferred first step in reducing operator noise exposure is the application of engineering controls. Engineering controls address noise at the source, reducing the sound levels and preventing overexposure of all personnel in the vicinity, not just the roof bolter operator. The NIOSH Office of Mine Safety and Health Research (OMSHR), in collaboration with Corry Rubber Corporation and Kennametal Inc., has developed a drill bit isolator to reduce drill-steel-radiated noise when drilling with 1-3/8" diameter drill bits.

The bit isolator is a noise control that reduces sound levels generated during drilling and can reduce the operator's risk of NIHL. The bit isolator (Figure 2) consists of two steel cylindrical tubes with a rubber layer between them. Hex-shaped drill steel couplers attached to the inner and outer cylinders allow the bit isolator to be connected in-line with the drill steel. The rubber layer isolates drill bit vibration from the drill steel, thereby reducing the noise radiated from the drill steel and the

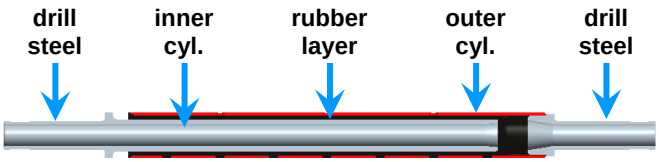

Figure 2. Drill bit isolator.

chuck. Consequently, the RBM operator is exposed to less noise.

With the bit isolator installed, the drill steel is used in the same manner as a standard hex drill steel. Figure 3 shows the bit isolator installed in a drill steel. A short piece of hex drill steel is installed between the isolator and bit seat. Any standard drill bit can then be used to drill 1-3/8" diameter holes. The bit isolator may be used for deeper holes by stacking an additional drill steel under the first piece of drill steel using a coupling.

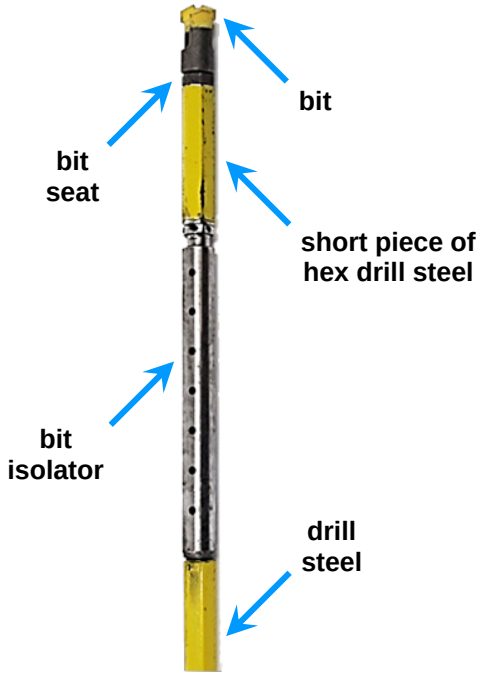

Figure 3. Drill bit isolator installed in a drill steel.

Results of Laboratory and Field Tests

In order to evaluate the effectiveness of the bit isolator, NIOSH OMSHR performed laboratory and field tests. The laboratory tests were conducted in OMSHR's hemi-anechoic chamber using an RBM and a rock test fixture. Tests were performed using Barre granite, which has demonstrated repeatable results during previous laboratory drilling tests. Sound level measurements were collected at the operator location. The bit isolator was also tested at various underground coal mines, where worker noise exposure and sound level data were collected.

The results from these laboratory and field tests show that the bit isolator significantly reduces noise generated by an RBM without increasing roof bolting cycle time. During laboratory testing, a 7 dB sound level reduction was observed at the operator location. The results from the in-mine testing show that using the bit isolator during drilling reduces sound levels by 4 to 7 dB. Noise exposure measurements underground demonstrated a 36% reduction in accumulated noise dose. This difference between a standard drill steel (solid line) and the bit isolator (dashed line) during an eight-hour work shift is illustrated in Figure 4.

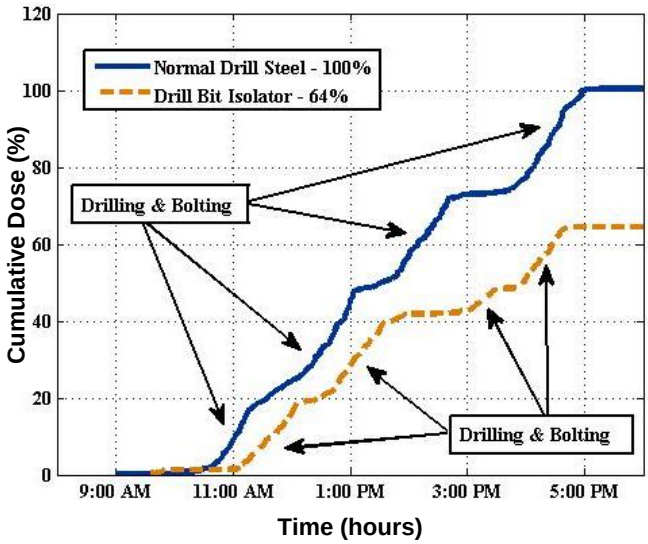

Figure 4. Operator noise exposure comparison shows reduction from 100% to 64%.

Summary

Addressing the dominant noise source with engineering noise controls is the best method to protect workers from noise exposure. The bit isolator is an effective and easy-to-use noise control that reduces worker exposure to noise during RBM operation. Laboratory and field testing have shown this control to be practical and effective in protecting workers from noise exposure in underground coal mining.

For More Information

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