CHAPTER 4.—PREVENTING METHANE IGNITIONS AT LONGWALL FACES

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In This Chapter

- ✓ Where methane is emitted at longwall faces
- ✓ Where methane accumulates at longwall faces
- ✓ Using the modified shearer-clearer to eliminate ventilation eddy zones
- ✓ Using a walkway curtain to reduce methane buildup during the headgate cutout
- ✓ Control of frictional ignitions

and

- ✓ The best location for the methane monitor

The methane released along a longwall face represents only 10%–20% of the total methane emitted from the entire longwall panel. Nevertheless, in very gassy coal seams, this methane released at the face can pose a problem because the shearer is a ready ignition source.

Preventing methane ignitions at longwall faces requires four actions. The first is to provide better ventilation around the shearer to eliminate the ventilation eddy zones at the drums where methane builds up. These eddy zones are eliminated by mounting additional water sprays on the shearer to direct air into them. The second action to prevent methane ignitions is to install a water spray behind each cutter bit and regularly replace worn bits. Water sprays behind each cutter bit act to quench the hot metal streak that follows a worn bit when it strikes rock. The third is to ensure that no ventilation eddy zones are inadvertently created by poor placement of water sprays. The fourth is to ensure that the methane monitor on the shearer is in the best location to detect methane accumulations.

ADDRESSING METHANE ACCUMULATIONS AT LONGWALL FACES[3]

Cecala et al. [1985a, 1989] and Denk and Wirth [1991] studied methane emission and ventilation patterns at longwall faces to find where methane accumulations are most likely. Although not always the case, the major source of methane at longwall faces is usually the breakage of coal by the shearer. Stress-related fracturing of the coal seam at the face, called bumps or bounces, can cause the release of additional gas (Figure 4–1).

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[3]Methane accumulations in longwall gobs are addressed in Chapter 5.

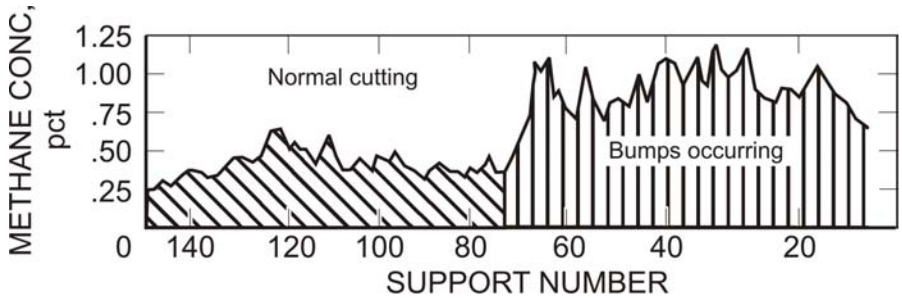

Figure 4–1.—Increased methane liberation during coal bumps.

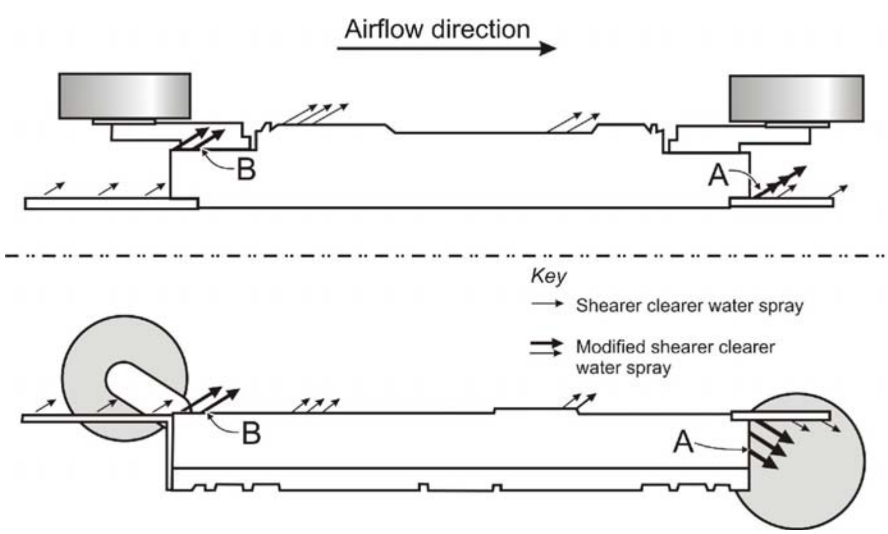

Figure 4–2.—Modified shearer-clearer system.

Methane accumulations around the shearer body. The quality of the ventilation around the shearer body impacts the accumulations of methane. For example, ventilation eddy zones around the shearer body are known to accumulate gas because the air exchange in and out of these zones is limited. Studies reported by Ruggieri et al. [1983] on a full-scale mockup of a longwall shearer face showed that the face-side area around both cutting drums and the entire area between the drums were less ventilated than other parts of the shearer. Further increasing the primary airflow or changing the cutting direction had little impact on improving the ventilation of these eddy zones.

Ventilation at the shearer can be improved by using a "modified" shearer-clearer[4] system to bring more air into these eddy zones. The modified shearer-clearer is shown in Figure 4–2. It differs from the original shearer-clearer system by the addition of three water sprays on the return-side splitter arm (shown as A in Figure 4–2) and two sprays on the head-side corner of the shearer body (shown as B in Figure 4–2). These sprays move air[5] toward the face side of the shearer body and toward the return side of each shearer drum—eddy zone regions where methane accumulations are likely. These extra sprays raise the shearer water consumption by about 20 gpm. According to Cecala and Jayaraman [1994], the modified shearer-clearer system lowers methane concentrations at the shearer by 73%.

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[4]The original shearer-clearer system was designed to reduce dust. It is an arrangement of water sprays mounted on the body of a longwall shearer. The purpose of these sprays is to induce an air current over the shearer body, which serves to hold the dust cloud against the face, keeping the dust out of the operator's walkway.

[5]Many studies [Ruggieri et al. 1985] have established that water sprays mounted on mining machines can move air in the vicinity of the machine and that this air movement can benefit methane control.

Cecala and Jayaraman [1994] have provided a detailed design and installation manual for the modified shearer-clearer system. It is available as a free pdf download from NTIS[6] as PB95104873.

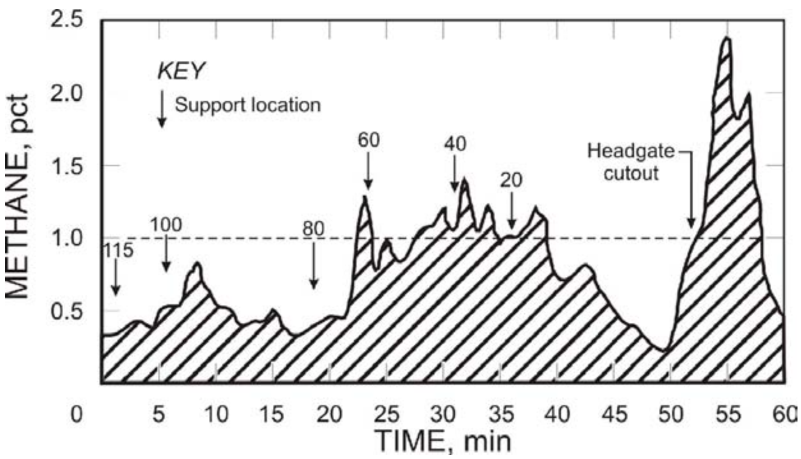

Figure 4–3.—Methane concentration at shearer during tail-to-head pass.

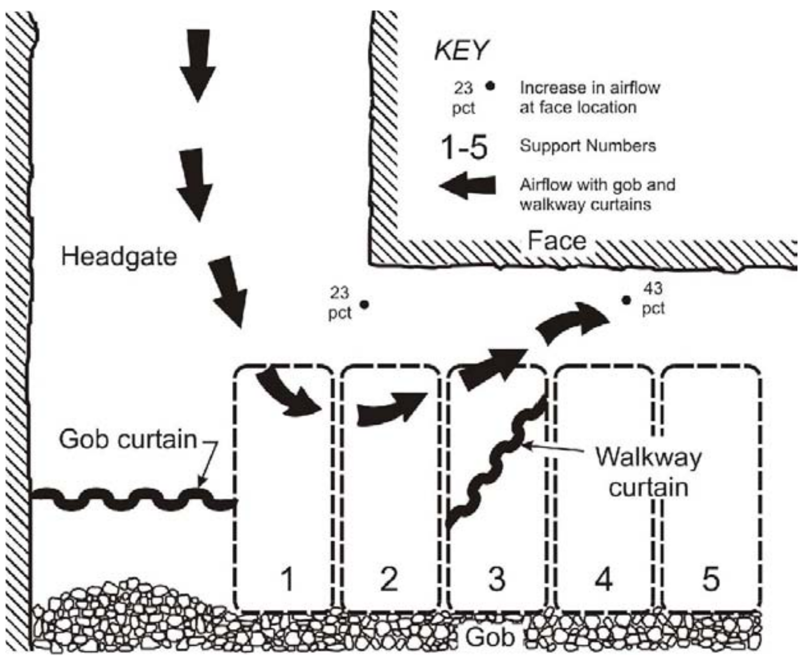

Figure 4–4.—Plan view of walkway and gob curtains (shearer not shown).

Methane accumulations during the headgate cutout. Ventilation at the shearer also suffers and the methane concentration rises as the shearer makes the headgate cutout (Figure 4–3). This rise in methane takes place because the air flowing down the headgate entry does not readily make the 90° turn as it reaches the longwall face. Thus, a portion can divert to flow through the legs of the first 8–10 supports. Because of this air diversion, the amount of air flowing over the shearer is not sufficient to avoid methane buildup. This buildup can be prevented with a walkway curtain.

The walkway curtain [Cecala et al. 1986], used to force more air over the shearer body during the headgate cutout, is shown in Figures 4–4 and 4–5. The curtain should be located across the walkway near support No. 3, extending from the support legs to the spill plate reaching from the roof to the floor. To be effective, it must be used in conjunction with a gob curtain, a dust control device already in use at most longwalls (Figure 4–4). The walkway curtain raises the air velocity over the shearer by 23% at the headgate

[6]National Technical Information Service, Springfield, VA. See www.ntis.gov.

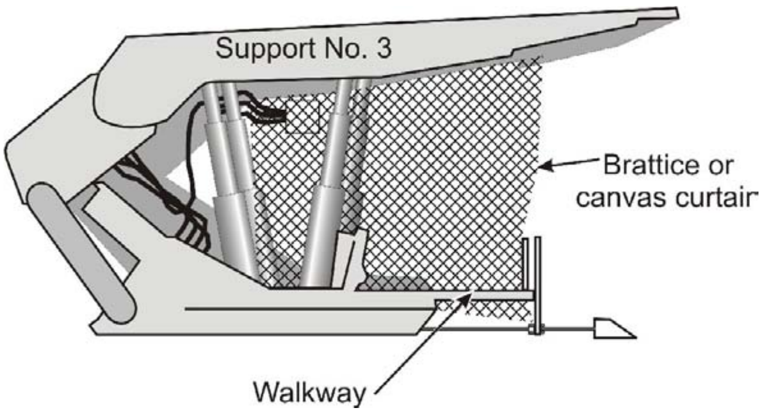

Figure 4–5.—Walkway curtain at support No. 3 forces air over the shearer.

corner and by 43% at support No. 4. These higher air velocities reduce the methane concentration by 60% during the headgate cutout.

During the longwall cutting cycle, the walkway curtain need only be in position during the headgate cutout. Since it is not needed for the remaining 95% of the cutting cycle, it should be tied up to keep it out of the way. For the remaining 95% of the cutting cycle, the modified shearer-clearer is used.

> **The modified shearer-clearer may need to be turned off during the headgate cutout. During testing of the combined systems, the high air velocity over the shearer created by the walkway curtain overpowered the shearer-clearer sprays and forced water mist over the tail-side shearer operator [Cecala and Jayaraman 1994].**

Methane accumulations caused by inadvertent eddy zones. Certain ventilation practices lead to the creation of inadvertent eddy zones. Figures 4–6 and 4–7 illustrate two ventilation mistakes that can cause an accumulation of methane. Figure 4–6 shows an upwind-pointing venturi spray mounted on the headgate end of a shearer. The venturi spray creates an airflow opposing the main ventilation flow direction along the face, thus creating an eddy zone where methane builds up.

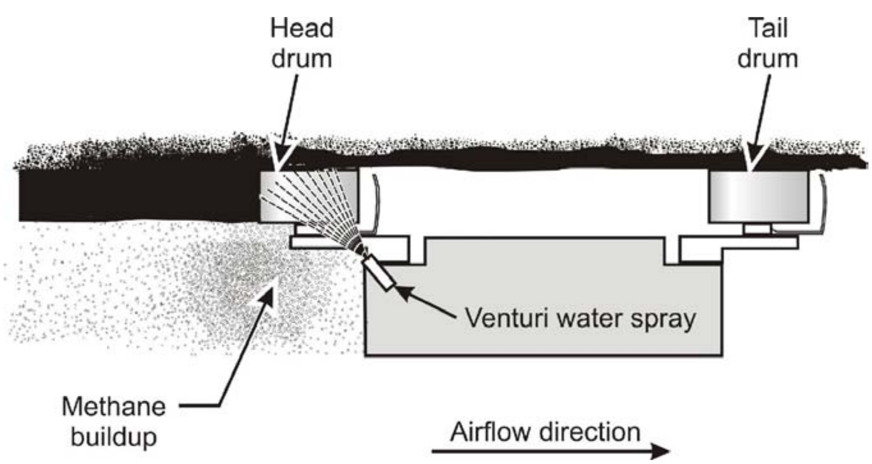

Figure 4–6.—Upwind-pointing venturi spray creates eddy zone and methane buildup.

Another type of eddy zone is shown in Figure 4–7, which depicts an L-shaped wing curtain used by some operators to control dust during the headgate cutout. Although convenient to use, it can allow the accumulation of methane.

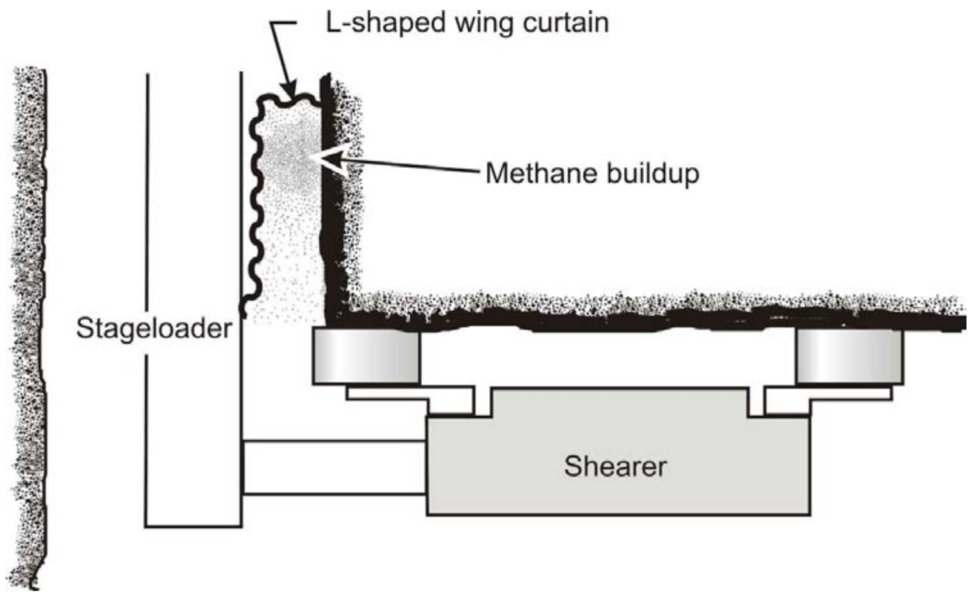

Figure 4–7.—L-shaped wing curtain, which can cause methane buildup.

REDUCING FRICTIONAL IGNITIONS

Aside from improving the ventilation to reduce methane accumulations in eddy zones, the chance of a methane ignition can be reduced by directly addressing the ignition source. When a shearer cutter bit strikes rock, abrasion from the rock grinds down the rubbing surface of the bit, producing a glowing hot metal streak on the rock surface behind the bit. The metal streak is often hot enough to ignite methane, causing a so-called frictional ignition.

At longwalls, there are two methods to lower the incidence of frictional ignitions. The first method concerns the bit itself—providing a regular change-out schedule to replace worn bits, providing bits with a larger carbide tip to reduce wear, and possibly changing the bit attack angle or the type of bit. These topics are covered in the continuous miner chapter (Chapter 3).

The second method is to mount a water spray behind each bit, aiming the spray toward the location on the rock where the hot metal streak is expected. This anti-ignition back-spray (Figure 4–8) quenches the hot streak, reducing its temperature and the chance of a frictional ignition.

Cecala et al. [1985b] reported how a U.S. longwall lowered methane frictional ignitions by mounting a water spray behind each bit and by slightly lowering the cutting height of the shearer to avoid roof rock. Actions taken in the United Kingdom to reduce frictional ignitions on shearers have been reported by Browning [1988].

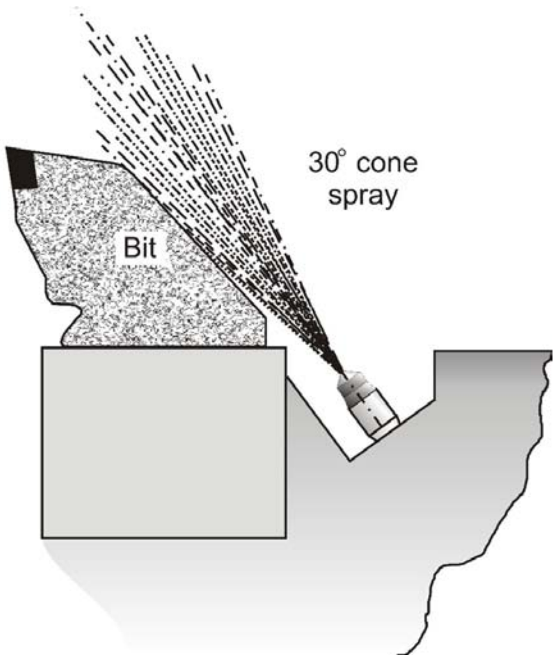

Figure 4–8.—Anti-ignition back spray.

When using water sprays to reduce frictional ignitions, the proper spray nozzle selection, nozzle placement, and operating pressure of anti-ignition back sprays are important if the full hot-streak quenching potential is to be realized [Courtney 1990; British Coal 1988]. For example, if the spray density is too low or if too much water is wasted in wetting the back of the bit, then quenching effectiveness suffers.

Longwall drums with anti-ignition sprays are commercially available.

A recent, comprehensive review of frictional ignitions in mines, including metal-to-metal ignitions and those from roof falls, is provided by Phillips [1996].

THE BEST LOCATION FOR THE METHANE MONITOR

Normally, it is required to use two methane monitors at longwall faces, one located at the tailgate and another on the shearer. Because the shearer is a primary ignition source at most longwalls and because the methane concentration at the shearer is generally higher than the concentration at the tailgate,[7] the shearer is usually the most critical location for the monitor. For example, during the tail-to-head pass shown in Figure 4–3, the methane concentration at the shearer exceeded 1.0% several times, and during the headgate cutout it approached 2.5%. However, at no time did a methane monitor that was located at the tailgate record a concentration over 1.0%. Even if enough gas were released at the shearer to exceed 1.0% at the tailgate monitor, there can be a considerable delay as the gas cloud travels down the face from the shearer to the tailgate monitor.

Because the shearer is usually the most critical location for the methane monitor, Cecala et al. [1993] conducted a study to establish the best location on the shearer. In this study, a full-scale laboratory facility was used to simulate a longwall face with a shearer. Methane was released at the drums, and the concentration was measured at several locations on the top of the shearer body (Figure 4–9).

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[7]On some longwalls, the tailgate concentration is higher.

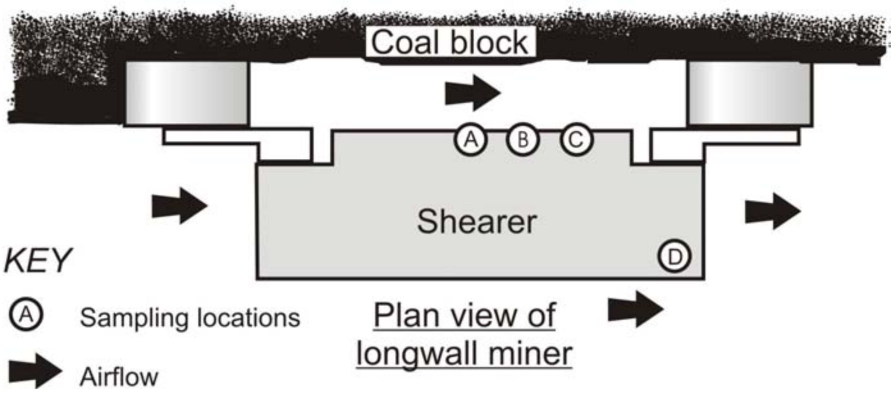

Figure 4–9.—Best methane monitor location.

Cecala et al. found that locations A through C on the face side of the shearer gave the highest methane concentrations and were approximately the same value. However, the drawback with a location on the face side of the shearer is that the methane monitor is prone to damage or to being covered with coal. Because of this, the best choice for a monitor location is usually at the gob-side tailgate-end of the machine, shown as location D in Figure 4–9. A monitor at location D is less likely to be damaged, covered with coal, or soaked by water sprays. However, the measured methane concentration is 40%–50% lower than that measured at face-side locations A through C.

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