LONGWALL DUST CONTROL PRACTICES

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ABSTRACT

Production levels in coal mines have increased dramatically in the past 15 years. In 1984, longwalls produced an average of 1,022 tons per shift. Today, it's common for mines to average up to 10,000 tons per shift for an extended period of time. These production levels have the potential to generate significantly higher levels of respirable mine dust. However, most longwall dust sample results indicate that compliance with the coal mine dust standard can be achieved and maintained. This paper will discuss the different components of an effective longwall dust control plan currently in place at high production longwall sections in MSHA, Coal Mine Safety and Health, District 2.

BACKGROUND

Title 30 Code of Federal Regulation Part 70.100 requires each operator to continuously maintain the average concentration of respirable dust in the mine atmosphere below 2.0 milligrams during each shift to which each miner in the active workings of each mine is exposed. The air must be measured with an approved sampling device. The concentration is then converted into an equivalent concentration as measured by a MRE instrument. Title 30 CFR Section 70.206 describes the conversion in detail.

The mine operator is also required by federal regulations to collect 5 consecutive respirable coal mine dust samples every 2 months on the designated occupation (occupation on a mechanized mining unit that has been determined by results of respirable dust samples to have the greatest respirable dust concentration). In most cases, this is the miner who works nearest the return air side of the longwall working face on the longwall section. This is often referred to as the 060 occupation. Mine operators can also conduct informational samples that will not be used for compliance determination at any time. Most operators do this type of sampling to evaluate changes or to determine dust generating sources that need to be corrected.

Under MSHA policy, MSHA inspectors collect respirable coal mine dust samples on each mechanized mining unit (including longwall sections) during each quarterly inspection of the mine or 4 times a year. The MSHA inspector will sample 5 face occupations. One of those will be the designated occupation. An intake air sample is normally taken along with informational samples that may be helpful in determining problem areas.

Most longwall personnel work extended shifts (9 or 10 hours). However, MSHA only requires the mine operator to take samples for an 8 hour shift. The sampling device is normally given to the miner on the surface before entering the mine and the device is removed from the miner at the longwall face to allow enough time for the sample to be transported back to the surface while remaining operational until it reaches the surface at the end of the 8 hours. The samples are then mailed to MSHA's Respirable Dust Processing Laboratory near Pittsburgh, PA. The laboratory mails the results back to the operator or MSHA office.

PLAN INFORMATION

In addition to collecting respirable dust samples, under part 75.370, mine operators are required to develop and submit plan information concerning minimum parameters that will maintain compliance with the dust standard. MSHA evaluates the operator's submitted plan. This evaluation includes an office review to determine if the plan seems feasible. If the office review finds the plan to be adequate, an in mine review is then done. It will in most cases include a respirable dust inspection. MSHA plan approval or denial will be based on sampling results, methane concentrations, production levels, parameters in place during sampling, and visual observations.

The following items are all components that need to be addressed to have an effective longwall dust control program:

INTAKE AIR

Dust levels in intake airways are not normally thought to be a significant contributor to personal dust exposure. This is often true for damp intake entries however, the operator may need to apply some type of effective dust allaying agent. Longwall intakes normally consist of only 2 entries and with panels now extending to 18,000 feet or more. It is imperative that the intake airway not be a dust problem. MSHA inspectors normally take a dust sample in the intake entry on the working section to be sure that the operator is maintaining less than 1.0 mg/m^3.

BELT AIR

The belt entry is an area where you typically generate dust. As higher production levels are seen, you would expect dust to also increase. Many of the mines are now dumping the air from the tailpiece to the mouth of the section into the main return. Ventilating from the tailpiece to the mouth of the section reduces the amount of dust that reaches the longwall face. It also dumps the methane that is liberated from the ribs and the coal on the belt itself into the return. In the Pittsburgh seam which has significant rib liberation, methane levels can sometimes reach close to 1%.

A few of the mines are using intake air from the belt entry as an additional source of air at the face. However, dust results indicate concentrations close to 1.0 mg/m^3, the maximum concentration allowed in intake air within 200 feet outby the working face. Dust needs to be allayed in the belt entry by an effective dust control system to minimize the amount of dust that will actually enter the face area. Typically, water sprays should be installed along the belt line every 700 to 1000 feet when belt air is used to ventilate the face. Additionally, a 1.0 mg/m^3 designated area is normally established outby the stageloader when the belt entry is used as an intake.

STAGELOADER

The stageloader is also a critical area for dust control. The stageloader contains the crusher that will break the coal into smaller pieces if the shearer has not already done that. If the coal is damp and has broken from the face easily, the dust generated at the stageloader can be minimal. However, if the coal is dry and has not been broken substantially at the face, a significant amount of dust can be generated at this location. The dust mixes with the intake airstream and impacts the exposure of the face personnel. Steel should be used to enclose stageloaders. This will help to establish a barrier to prevent the generated dust from entering the longwall face. Conveyor belting should be placed over the crusher inlet. This will help contain the dust. Water sprays should be installed at the inlet to the crusher and at other points within the crusher to control the dust. There should normally be three banks of sprays in the stageloader. The sprays should be located at the inlet, at the crusher picks or teeth, and at the crusher outlet. A bank of sprays would also be helpful where the stageloader dumps onto the belt.

It is imperative to minimize the concentrations of dust generated by the stageloader. MSHA personnel will normally take an informational sample inby the stageloader to measure dust concentrations. Inspectors have found results as high as 1.8 mg/m3 inby the stageloader. This means that a concentration exceeding only 0.2 mg/m^3 generated from the shearer and shield movement on the face will result in the level exceeding the 2.0 mg/m^3 standard.

In addition to enclosures and water sprays, dust collectors can be used to reduce the dust generated from the crusher and stageloader. Two types of dust collectors have been used. These include flooded bed scrubbers and filter dust collectors. In either case, the negative pressure induced by the air flow into the crusher and stageloader confines the dust and the flooded bed scrubber or filter removes the dust. These systems are currently used in western coal mines.

LONGWALL FACE VENTILATION

If proper dust control can be effectively maintained in the intake entry, belt entry, and at the stageloader, the dust should be relatively low when reaching the longwall face. If the area behind the longwall shields near the headgate is permitting air leakage into the gob, line brattice (gob curtain) should be used to decrease the amount of air from entering the gob. It may be possible to use curtains or belting to deflect the air down the face area to keep it from entering the gob near the headgate.

One of the most important factors for longwall dust control is the ventilation along the longwall face. For the nine longwall sections operating in District 2, the section intake air flow ranges from about 35,000 to 73,000 cfm. More importantly than the intake air flow is the amount of air coursed along the face. In District 2, actual longwall face velocities ranged from 500 to 800 fpm. With an area along the face of approximately 80 square feet, the face air quantities range from 40,000 to 64,000 cfm.

SHEARING MACHINE

Shearing machine dust control normally includes a water spray system that creates an "envelope" of operation that keeps the dust closer to the longwall face. This minimizes the dust entering the shield walkway area where the personnel operating the longwall are located. Both internal and external spray types may be used. Internal sprays suppress dust before it can become airborne. External sprays direct the dust that is already airborne away from the longwall personnel. Dust suppression at the shearing machine can be accomplished by proper orientation of the water sprays and regulating the pressure at three typical spray locations. The three different typical spray locations are: drum sprays, shearing machine mounted sprays, and ranging arm sprays. Shearer drums normally have one spray per bit. The water sprays operate at a typical pressure of 80 pounds per square inch (psi). For dust control, the sprays are normally directed to spray onto the bit just as the bit is mining into the coal. Where methane is a problem, the spray is normally oriented to spray onto the rear of the bit just as the bit has mined into the coal. The second location for sprays are shearing machine mounted sprays. These external sprays are used in a number of ways. They aid in confining the generated dust to the face, to wet the roof before shield movement occurs, to wet the toes of the shields that aids in cleanup as well as dust control, and to assist air movement throughout the shearing machine area. The ranging arm sprays normally consist of about 8 sprays. They are extended onto the headgate side of the shearer and are also used to direct the airflow through this area as well as keeping the dust trapped along the longwall face until it passes the shearing machine on the tailgate side. The spray pressure of machine mounted sprays and ranging arm sprays are normally higher than the drum spray pressure. The average pressure is about 120-150 psi.

MINING SEQUENCE

There are three cutting sequences available for longwall face operations. These include: unidirectional - head to tail main cut; unidirectional - tail to head main cut; and full bidirectional cutting. For the unidirectional - head to tail sequence shields are advanced and the panline is pushed on the tail to head cleanup pass. For the unidirectional - tail to head sequence, shields are advanced and the panline is pushed on the head to tail cleanup pass. For the full bidirectional cutting sequence the shields are advanced and the panline is pushed on both head to tail and tail to head cuts. The contribution of each dust source to the occupational exposure depends on the magnitude of the dust source and the amount of time that is spent downwind of the source.

The majority of mines in the United States mine prefer bidirectional cutting. This means that the shearing machine is mining coal in both directions of travel. This can create a more dusty environment than mining unidirectional but it is also the most cost effective and will yield the highest production.

LOCATION OF LONGWALL PERSONNEL AND SHIELD ADVANCEMENT

The location of longwall face personnel is also an important component to respirable dust compliance. For instance, a shieldman would not want to stay near the tailgate while the shearing machine was mining on the headgate side of him. All of the dust generated would pass directly over this individual. In addition, this person would be the furthest downwind and represent the 060 occupation.

MSHA inspectors will normally take a respirable dust sample within 4 shields of the tailgate entry for informational purposes. Occupation 061 is defined as 48 inches from the tail. This represents the entire amount of dust that is measured on the longwall face. Surprisingly, there have been sample results from this location which were less than 2.0 mg/m^3. These samples were taken in conditions that were very damp to wet. Conversely, there have been samples with results up to 6 mg/m^3. This information gives the operator an idea of how well the designated occupation sampling compares to the total dust on the longwall face.

Most shield systems are now equipped with "shearer initiation". This means that the shields are automatically programmed to advance without someone having to actually prompt movement by manually pushing a button on each shield. However, most mines seem to operate manually instead of the automated shearer initiation. In most cases, this is based on geologic conditions of either the roof or floor, a problem with the electronics of the shield advancement, or because the shield operator feels more comfortable in moving the shields forward manually. Shield dust can also be a major source of respirable dust depending on the dryness of the coal and the location of inby personnel.

Many shield systems now have water systems installed within each shield with a number of sprays to wet the roof just prior and during shield advancement. Shields come equipped with three types of sprays. Top sprays wet the roof as the shield is advanced. Gob sprays wet the gob behind the shield and canopy sprays wet the face. The operation of these sprays can be programmed to suit the operation. Sprays have also been installed along the panline to wet the coal as it travels along the face. These sprays can be operated continuously or cycled in front of the shearer. For shields without water sprays, operators manually wet the roof just prior to shield advancement.

All of the mines in District 2 have implemented a work practice that limits the distance that the shieldman can be downwind of the shearing machine when cutting from tailgate to headgate. It basically requires the shieldman to be within a 5-7 shield area downwind of the shearer. The shearing machine will stop if the shieldman is located beyond this "envelope" and wait for them to catch up. The shearing machine is operated by 1 or 2 personnel depending on the mine and conditions. The shearing machine operators normally operate the machine using a radio remote control and positioning themselves between the intake side of the machine and the body of the machine.

Some mine operators have also addressed the location of the shieldmen when mining from headgate to tailgate. They maintain a fifteen shield separation between the shearing machine and the advancement of shields when going from headgate to tailgate. They feel that this additional distance between the shearer operators and the shield movement allows the dust from the shields to disperse somewhat by the time that it gets to the shearer operator than if the shield movement was done close to shearer operators.

Mine operators should follow these same work practices when making a cutout or a wedge cut. Cutouts are made when cutting into either the headgate or tailgate entry. Wedge cuts are made at these same areas as a way to gradually wedge the machine into the coal seam until the shearing drums are back into the position to take a full cut of coal. This takes an average of 150 feet or about 30 shields to fully wedge the drum into the coal.

CUTTING SPEED

The speed of the bits on the longwall drum have an important impact on the amount of dust generated during cutting. If the bits turn too fast, the coal is ground out of the face instead of broken from the face. Grinding coal creates more dust than breaking the coal. Typically, the longwalls in District 2 have a drum rotational speed of 45 rpm and a drum diameter of 54 inches or less. This results in a bit tip speed of less than 640 fpm.

ON-SHIFT EXAMINATION OF DUST CONTROL PARAMETERS

The on-shift examination of dust control parameters is an important part of an effective dust control program. It includes both measurements and observations of dust control parameters that are included in the ventilation plan. Regulations require an examination of these respirable dust control parameters before any production begins or within 1 hour of the shift change if personnel have changed out at the face. The examination is intended to insure that the minimum parameters are in place. These minimum parameters were designed to continuously maintain the dust levels within allowable limits.

RESPIRATORY EQUIPMENT

Regulations require that mine operators make respirators available to all personnel whenever they are exposed to concentrations of respirable dust in excess of the allowable levels. All District 2 longwall crews are offered the use of air purifying respirators. The majority of personnel who work on the face wear these air purifying respirators. However, the use of a respirator can not be substituted for compliance with the respirable dust standard. While it can be used as an additional way to protect face personnel from dust, respirators are intended to be used only as an interim control measure or for short term exposure.

LONGWALL SAMPLING RESULTS

Table 1 shows longwall sampling results for the designated occupation 060, production levels and face air velocity at each of the nine longwall mechanized mining units (MMUs) in District 2 during the May-June, 1999 bimonthly period. The latest MSHA sampling result is also included for each of these MMUs.

All of the longwalls had respirable dust concentrations on the designated occupation less than the 2.0 mg/m^3 standard. This is based on both operator and MSHA samples. MSHA measured dust concentrations on the 060 occupation ranged fro 0.75 To 1.56 mg/m^3. Productions on operator sampling shifts ranged from 1622 to 10,869 tons. Productions on MSHA sampling shifts ranged from 2050 to 8504 tons. Face air velocities on MSHA sampling shifts ranged from 412 to 833 fpm at the headgate and 360 to 775 fpm at the tailgate.

SUMMARY

A successful longwall dust control program utilizes an integrated approach of controls which incorporate ventilation, water sprays, enclosures, cutting and work practices. The airflow along the longwall face must be sufficient to dilute and carry away dust that has become airborne. Water is applied at the crusher/stageloader, shearer drums, shearer body, ranging arms, shields and panline to suppress and direct dust away from workers. The speed of the cutting bits is limited to cut rather than grind coal from the face. Work practices are utilized to reduce the amount of exposure to the various dust source. Longwall operators in MSHA District 2 have been successful in implementing these technology to control respirable dust on their longwall faces. Monitoring of dust levels and dust control parameters verify that the controls are operating properly.

Table 1. Results of Operator Bimonthly and MSHA Inspector Longwall Respirable Dust Samples (Designated Occupation 060), CMS&H, District 2, May-June, 1999.

MMU	Dust Concentration, mg/m^3	Production tons	Face Air Velocity(fpm) HG	TG
MMU 1	Operator sample			
	1.377	4275		
	2.028	5826		
	1.571	3014		
	1.246	5344		
	0.904	3644		
	Avg. 1.425	Avg.4420		
	MSHA sample			
	1.116	3978	507	425
MMU 2	Dust Concentration, mg/m^3	Production tons	Face Air Velocity	
	Operator sample			
	1.012	1622		
	0.567	1781		
	0.493	1824		
	2.226	2050		
	0.889	2147		
	Avg.1.037	Avg.1884		
	MSHA sample			
	0.959	2050	412	360
MMU 3	Dust Concentration, mg/m^3	Production tons	Face Air Velocity	
	Operator sample			
	0.889	3030		
	1.474	5698		
	0.744	2896		
	0.930	2880		
	0.615	2870		
	Avg.0.930	Avg.3474		
	MSHA sample			
	1.547	4713	488	299

Table 1. Continued

	Dust Concentration, mg/m^3	Production tons	Face Air Velocity	
MMU 4	Operator sample			
	0.527	2100		
	1.480	6600		
	1.713	8700		
	1.147	6600		
	1.533	8400		
	Avg.1.280	Avg.6480		
	MSHA sample			
	0.973	7020	833	775
MMU 5	Operator sample			
	1.023	10869		
	1.066	6340		
	0.806	5440		
	1.654	8680		
	0.829	5760		
	Avg.1.075	Avg.7417		
	MSHA sample			
	1.537	8504	810	627
MMU 6	Operator sample			
	1.085	2640		
	1.956	5500		
	0.885	2640		
	1.526	3960		
	0.609	2090		
	Avg.1.212	Avg.3366		
	MSHA sample			
	1.569	6105	572	423

Table 1. Continued

MMU 7	Dust Concentration, mg/m^3	Production	Face Air Velocity	
	Operator sample	tons		
	0.797	4620		
	0.859	4840		
	0.655	3960		
	0.714	2640		
	0.892	3300		
	Avg.0.783	Avg.3872		
	MSHA sample			
	0.753	5670	520	511

MMU 8	Dust Concentration, mg/m^3	Production	Face Air Velocity	
	Operator sample	tons		
	2.300	4182		
	1.660	4182		
	2.150	4879		
	2.131	4182		
	1.594	4531		
	Avg.1.967	Avg.4391		
	MSHA sample			
	1.472	6240	530	560

MMU 9	Dust Concentration, mg/m^3	Production	Face Air Velocity	
	Operator sample	tons		
	1.666	4400		
	0.769	1925		
	1.101	4400		
	0.967	3575		
	0.894	3025		
	Avg.1.079	Avg.3465		
	MSHA sample			
	1.399	4125	575	560