SUMMARY OF MINIMUM DUST CONTROL PARAMETERS

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ABSTRACT

MSHA has prepared two pamphlets that provide guidelines for selecting dust control parameters for underground coal mining sections. These guidelines are based on research conducted by the Bureau of Mines and underground studies conducted by MSHA. One set of guidelines is specific for longwall mining operations. Another set of guidelines covers room and pillar operations. The guidelines contain a general discussion on the appropriate use of ventilation and water to optimize the control of dust.

INTRODUCTION

The Mine Safety and Health Administration has long recognized that only through the proper application and maintenance of appropriate dust control measures can respirable dust levels be adequately controlled. Consequently, regulations require mine operators to have, and follow, a plan specifying the practices that are to be employed to control respirable dust levels to mandated standards. Although each plan is generally customized for a specific mining operation, experience has demonstrated that there are minimum levels of ventilation and water application that are necessary to continuously maintain respirable dust levels at or below the current applicable standards.

This paper discusses the minimum measures the Agency is recommending for the control of dust on longwall and continuous mining sections. These measures are considered a base line dust control system that can be upgraded as necessary for a specific operation.

Dust control measures may be classified into two general types; environmental controls and administrative controls. Environmental controls include methods that minimize the level of dust in the mine atmosphere by either reducing dust generation or by suppression, dilution, or by capturing and containing the dust.

Unlike environmental controls, administrative controls or "work practices" are designed to minimize the exposure of individual workers by positioning them in the work area in such a way as to limit the time they are exposed to a particular dust source.

LONGWALL PLAN PARAMETERS

Ventilation. Adequate ventilation is needed to dilute, capture and remove both respirable dust and methane gas generated during mining. In principle, the concentrations of dust in the air can be halved if the quantity of air with which the dust is mixed is doubled. Analysis of MSHA inspection results show that to maintain the designated occupation at or below 2.0 mg/m^3 will require approximately 0.14 to 0.57 cubic meters per minute of air per ton of material mined during the shift be maintained along the longwall face. In addition to

production, the actual amount of air required is also dependent on the dustiness of the coalbed and on the effectiveness of other dust control measures in place.

The air quantity required per ton of material mined is obtained as follows:

$$R = \frac{C \times Q}{S \times T}$$ Where:

R = Airflow-to-tons ratio, $m^3/m/ton$
C = Actual dust concentration, mg/m^3,
Q = Face airflow, m^3/m
S = Applicable dust standard, mg/m^3, and
T = Production, tons.

For any value of "R" higher face quantities and velocities will be required as production increases. These higher air quantities help to control dust by providing more air for better dilution of intake dust and dust generated during support movement.

In addition to the quantity of ventilating air, face airflow control devices are also important parameters. Three airflow control devices for use on longwalls are: gob curtains, cut-out curtains and air- splitting barriers. Gob curtains are used to control the air leakage into the gob at the headgate and to maintain airflow along the face. The need for the curtain depends on the tightness of the gob and the section ventilation. A gob curtain would be particularly useful in maintaining face air flow prior to obtaining a tightly caved gob.

Cut-out curtains are used to increase the air velocity across the shearer operator and reduce dust rollback over the operator during cutting out at the headgate. A brattice cloth curtain is installed in the belt entry, from the longwall coal block across the crusher/stageloader.

Air-splitting barriers are used to separate the airflow along the face and provide a clean air split in which the shearer operator can work. Typically, such barriers are made by hanging conveyor belting, along the body of the shearer that extends to the roof. Barriers may also be line brattice installed along the face, between the walkway and the face conveyor.

Water Application. Water delivered through spray nozzles is used to suppress newly formed dust to prevent it from becoming airborne, to direct airflow, and to wet the coal. Since it is very difficult to control dust once it becomes airborne, all control measures should aimed at suppressing it at the source. A properly designed water spray system can reduce respirable dust from 20 to 60 percent. To effectively control dust, a shearer must be equipped with two types of water spray systems--internal drum sprays and external machine sprays. Internal drum sprays suppress dust before it becomes airborne, while external machine sprays direct airborne dust away from the shearer operator.

Drum sprays consist of nozzles mounted directly on the cutting drum to deliver water as close to the primary point of dust generation as possible. The most commonly used drum water spray system is pick-point flushing. This system employs nozzles mounted in the bit blocks or in special blocks immediately in front of the bits to direct the water directly to the bit/coal interface. The reverse pick-point flushing system utilizes spray nozzles mounted behind the bits to direct the water over the rear portion of the bit shaft to provide bit cooling, and to cool the hot streaks left in the rock after the bit passes. Reverse pick-point flushing is primarily an anti-incendiary spray system, however tests have shown that both pick-point and reverse pick-point flushing systems are most effective with solid-stream spray nozzle designs. For optimum effectiveness, a water filtration system should be

used to prevent clogging of the spray nozzles.

It has been shown that the dust suppression effectiveness of drum sprays increases with increasing water quantity. Typically a drum should be equipped with one spray per bit. A minimum water quantity of 130 liters per minute (lpm) per drum and, depending on the type of bit used, an operating water pressure ranging from 480 to 830 kPa is recommended.

On most longwall faces, the air upstream of the shearer is relatively clean if proper controls have been applied in the headgate area. If this airflow can be split and the dust cloud generated by the cutting drums confined to the face side of the shearer, the shearer operators can be supplied with a split of clean air. Proper location and orientation of the external sprays will utilize the air moving capability of the sprays to confine the dust cloud generated by the cutting drums to the face side of the shearer. Improperly oriented externally-mounted sprays aimed at the head drum can direct dust from that drum upstream where it can mix with the primary airstream and be carried back over the shearer operators.

Many external spray configurations are possible. One common configuration has sprays oriented toward the face approximately 30 degrees with the direction of air flow. The sprays are mounted on the body of the shearer and on a splitter arm extending from the headgate side of the machine. The sprays should be operated at a minimum nozzle pressure of 1035 kPa.

The contamination of intake air can be a significant problem on many longwall faces. While several sources contribute to the problem, the dust generated by the crusher/stageloader is the single largest source. The breaking action of the crusher generates a large quantity of dust. This dust mixes with the intake airstream and is carried along the entire length of the longwall face. Since this dust source contributes to the full-shift exposure of all face personnel working downwind, it can have a significant impact on respirable dust exposure. To minimize the amount of dust generated, it is important to equip the crusher/stageloader with a properly designed dust suppression system.

The two primary methods of controlling the dust generated by the crusher are to: (1) install water sprays at the inlet of the crusher and at various points within the crusher/stageloader; and (2) tightly enclose the unit with steel plate to prevent escape of the dust cloud. Also, conveyor belting should be placed over the crusher inlet. At a minimum, the crusher/stageloader enclosure should contain three banks of sprays: one at the enclosure inlet, one over the crusher picks, and one at the crusher outlet. Each spray bar should contain at least three sprays and operate at a minimum pressure of 480 kPa. Provisions should be made to allow for ease of inspection and maintenance of all sprays.

Moisture on the coal is subject to evaporation during travel between transfer points, which may be several thousand feet apart. Additional wetting of the exposed coal surface is suggested to prevent dust particles from dislodging and becoming airborne during transfer. Consequently, in addition to the sprays inside the crusher/stageloader enclosure, a bank of at least three sprays should be installed at the stageloader-to-belt transfer point. Applying approximately 11 lpm of water at 345 kPa to the coal at these transfer points will help control dust generation.

In addition to ventilation and water, which make up the key elements of a basic longwall dust control system, other measures are available and should be considered when optimizing a dust control system. The effectiveness of

some of these controls will be influenced by equipment design and geologic conditions. Other listed approaches have limited dust control potential but are viewed as good practice and should be part of an overall dust control strategy.

Roadway Dust Control. Roadway dust control may be required when construction, supply haulage, and roadway grading or cleanup activities are being conducted in the section intake air entries during the production shift. This source of background dust is generally low, but sometimes can affect face workers when roadways are located in the intake air of production sections. If haulage activities must take place during a production shift the haulage roadways must be kept damp. Since water will likely evaporate in the ventilation air, a hygroscopic salt or effective dust allaying agent should be used.

Wetting Agents. Wetting agents (surfactants) are chemical additives that reduce the surface tension of water and make it easier for the water droplet to wet a dust particle. Because such agents require a relatively long reaction time, their effectiveness in reducing dust generation during coal cutting is minimal. They will, however, when applied at the face, reduce dust generation at outby transfer points.

Foam Application. Foam application at the point where the dust is generated will suppress dust close to its source and prevent it from becoming airborne. The use of a properly designed foam application system can reduce exposures and provide reductions in water consumption requirements. Tests have shown that foam is more effective when applied directly at the point of dust generation, through the shearer drum sprays rather than through external sprays.

Water Infusion. Water Infusion is a method to reduce dust generation during mining by increasing the moisture content of the coal. Longwall panels are infused by drilling horizontal holes from the development entries to the center of the panel. Holes are typically drilled into the longwall panel during development. During longwall operations water is pumped into the holes in advance of mining. The effectiveness of water infusion is a function of the infused time and the amount of water the coal seam accepts (its infusibility), which depends on cleat density (cleat spacing) and cleat size (crack diameter).

Use of Remote Control Devices. The dust exposure of the shearer operators is influenced by their position relative to the cutting drums and direction of airflow. The use of a remote control device enables the shearer operators to control shearer functions from locations that are less dusty than their normal control stations. The two types of remote control units currently available are a wireless radio and an umbilical (hard wire) type. With either type, the head-drum operator can control the shearer from a distance up to 6 meters on the intake-air-side (upwind) of the shearer. Also, the tail drum operator's station can be located across from the head drum. Since a remote control device does not control the amount of dust in the mine atmosphere, it is considered to be an administrative control.

Additional Dust Controls Before Initial Roof Fall. Additional dust controls before initial roof fall involving the use of line brattice along the walkway and/or belting behind the shields can maintain adequate ventilation along the longwall face to dilute and carry away the generated dust prior to the initial roof fall. Line brattice and/or belting is suspended along the shields either in front (face side) of

the rear legs if a 4-leg support system is used, or on the gob-side of the legs of a 2-leg support system. In some support designs the canopy ends one foot from the base, resulting in a sizable open area through which air can escape into the gob. To minimize air leakage into the gob at the support base, the brattice curtain should extend to the base of the support.

On-Shift Examinations of Dust Control Parameters. On-shift examinations of dust control parameters are critical to an effective dust control strategy. Conducting such checks on a regular basis will ensure that the provisions of the approved plan, which was designed to continuously maintain the working environment free of excessive levels of respirable dust, under typical operating conditions, are being followed. On-shift examinations involve visual observation and measurement of control parameters stipulated in the plan.

Respiratory Protection. Respiratory protection should be provided and worn by workers when entering an area where they may be exposed to dust levels in excess of the applicable standard, or while controls are being installed. However, current regulations prohibit the use of approved respirators as a substitute for environmental control measures. Such devices are intended to be used only as an interim control measure until adequate engineering controls are installed. For a respiratory program to be effective, respirators must be properly selected, fit tested, maintained, and worn, according to ANSI Standard Z88.2-1969, "American National Standards Practices for Respiratory Protection".

CONTINUOUS PLAN PARAMETERS

Ventilation. The velocity and quantity of face ventilating air appears to be the most important factor in controlling the respirable dust exposure of the continuous miner operator and helper. By the use of good face ventilation, the dust generated by coal cutting can be confined toward the face which would virtually limit the operator and helper's exposures to intake dust sources such as shuttle car loading and haulage.

The widespread use of exhausting face ventilation may be attributed to the fact that intake air is coursed over the continuous miner and shuttle car operators, minimizing their respirable dust exposures. However, if the exhaust system is to be effective for dust control, it must be properly installed and maintained. Unless otherwise approved by the District Manager, a minimum mean entry velocity of 0.30 m/s is required. Also, the end of the curtain or tubing must be kept within three meters of the face. In order to minimize the leakage through the brattice directly into the return, it may be necessary to support the brattice by means of a wooden frame. Even when the curtain is properly maintained, most of the primary airflow goes directly to the end of the brattice, only a small portion of the secondary airflow reaches the face.

Water Application. Water sprays are generally used to accomplish three tasks; moving air, suppressing dust and wetting the coal. Venturi and hollow-cone nozzles are most effective for moving air. Atomizing and hollow-cone nozzles are most effective for capturing dust. Full-cone, flat-spray and solid-stream nozzles are most effective for coal wetting.

Previous studies have shown that most dust generated by continuous mining machines occurs under the boom as the cutter head shears down. The primary source of respirable quartz dust on many continuous mining sections is cutting or trimming roof rock immediately prior to shearing. This

results in very high concentrations of respirable coal and quartz dust being momentarily confined under the boom. Water sprays located under the boom can be used to control respirable dust trapped in this location before being pushed into the primary airflow. For underboom sprays to be effective, they must be located where they will not be easily damaged, and must be accessible for maintenance without having to block the boom with cribs. The most practical location is in the rear corner of the shovel at the side of the mining machine. A minimum water quantity of 3-7 l/min should be delivered through each spray. The operating water spray pressure should range from 480 to 830 kPa for top and side mounted sprays, and for the under-boom sprays.

Intake Dust Sources. Intake dust levels are not considered a significant contributor to personal exposures on sections having a 2.0 mg/m^3 respirable dust standard. However, this may not be the case if the mining machine operator is on a reduced standard. The primary dust source on intake air is the unloading of the shuttle car at the section dump point. Additional dust will be generated if a feeder/breaker is incorporated into the dump point. The use of water sprays may be required at this transfer point to knock down dust and also to wet the coal. Either a full cone or hollow cone type spray nozzle is suitable for use at this location. Also, redistributing a small portion of the water available on the continuous mining machine to the chain conveyor may be necessary to ensure that the loaded coal is wet enough to minimize dust re-entrainment at the section loading point.

Machine Mounted Scrubbers. A successful scrubber installation is dependent on inlet location and the scrubber airflow. In general, the inlets should be located as close as possible to the face on the bottom and sides of the cutter boom. The number of inlets should be limited, generally to no more than four, since increasing the inlet area will reduce the inlet velocity for a particular scrubber airflow. An inlet air velocity of approximately 28 m^3/min will provide good dust-capture efficiency.

To provide for good capture efficiency with a flooded-bed scrubber, the duct air velocity should be 56 m^3/min at the filter panel. In addition, the rated scrubber capacity should not be radically different from the airflow behind the curtain; and, if possible, should be very similar.

Roof Bolters. The roof bolting machine's dust collector is the primary means of controlling dust generated by drilling holes for the roof bolts. If the dust collector is properly maintained, very little dust can be measured. Poor maintenance, however, frequently results in high dust levels. Proper maintenance of the dust collection system includes the repair of leaks, replacement of damaged filters and replacement of worn or damaged hoses.

Dust escaping from the drill hole collar prior to full bit penetration is another source of roof bolter dust exposure. The quantity of dust escaping from the drill hole collar is dependant on the type of drill bit that is used. Although there are many different drill bits available, they fall into two general categories; shank-type bits and "dust hog" type bits. Shank-type bits allowed from three to ten times more dust to escape from the drill hole collar during drilling. Most of this dust escaped in the first few millimeters of bit penetration. Typically, the dust hog bits liberated one-fifth of the dust generated by shank bits in the initial 300 millimeters, and one-third of

the dust over the full length of hole.

In many sections, the roof-bolter operator must work on the return side of the continuous miner during part of the production cycle. Respirable dust levels downwind of the continuous miner are usually very high, and the dust often contains a significant percentage of quartz. In coal mining sections that use auxiliary fans and tubing to ventilate the continuous miner face, the exposure of roof bolters working downwind of the miner can be significantly reduced by adding a sufficient length of tubing to the fan discharge so that the miner-generated dust is carried directly to the section return.

Dust control measures for roof bolters mounted on the continuous mining machine are similar to control measures employed on mobile roof bolting machines. Because roof bolters mounted on the continuous miner allow for cuts greater than six meters, it may be necessary to use a dust box big enough to hold all the drill cuttings produced by bolting the entire cut. This will allow the dust box to be emptied, after the entire cut has been mined and bolted, at a remote location (such as the return) where the cuttings will not be disturbed and resuspended in the air stream.

SUMMARY

The Mine Safety and Health Administration has prepared two pamphlets which provide information on dust control techniques for continuous and longwall mining sections. These recommendations are considered a base line dust control system that can be upgraded as necessary for a specific operation.