OVERVIEW OF RESPIRABLE DUST CONTROL FOR UNDERGROUND COAL MINES IN THE UNITED STATES

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ABSTRACT

Control of respirable dust is an important consideration in the design of the production cycle of an underground coalmine. In order to create an effective and efficient system, the mining engineer must integrate the regulatory requirements with the specific conditions that exist in a coal mine. Typical mine development is by room and pillar. Second mining is by mining rooms, extracting pillars or by retreating longwalls. Each of the mining systems can have specific constraints depending on the type of equipment used. Continuous miners and conventional mining systems (cut, shoot and load) are used for room and pillar application. Single and double drum shearers primarily are used for retreating longwall systems. This paper provides a review of the specific federal regulations affecting dust control and description of the various dust control systems commonly used to supplement those regulations for the various mining systems.

INTRODUCTION

There are over 2,000 mechanized mining sections in underground coal mines in the United States. Each of these sections must utilize a dust control system capable of maintaining their dust levels below the specified standard.

The purpose of this paper is to provide an overview of the specific federal regulations affecting dust control and a description of various respirable dust control systems currently used in underground coal mines. Utilization of these systems has been successful in controlling workers exposure to coal mine dust.

FEDERAL REGULATIONS

Current authority to establish and enforce a respirable coal mine dust standard was given to the Mine Safety and Health Administration (MSHA) of the Department of Labor through the Federal Mine Safety and Health Act of 1977. Primary responsibility of enforcing the respirable dust standard rests at the federal level as state laws generally do not specify a respirable dust standard. Specific regulations pertaining to the dust standard and dust control are contained in Title 30, Code of Federal Regulations.

Part 70—Mandatory Health Standards—Underground Coal Mines, contains the dust standards and the sampling procedures that must be followed by the coal mine operators. Part 70 establishes a respirable coal mine dust exposure standard of 2.0 milligrams per cubic meter (mg/m^3). If the dust contains more than five percent quartz, the dust standard is computed by dividing the percentage quartz into the number 10. Additionally, Part 70 establishes a dust standard for intake air of 1.0 mg/m^3. Part 70 also requires mine operators to collect and submit five dust samples from a designated occupation during each bimonthly sampling period.

Part 75—Mandatory Safety Standards—Underground Coal Mines, contains various ventilation regulations that pertain to the control of respirable coal mine dust. Part 75 contains various regulations pertaining to the design and performance of a mine's ventilation system which also have an impact on dust control. Specifically, each mechanized mining unit must be ventilated on a separate split of intake air. This prohibits series ventilation of working sections so that the return of one section cannot be used to ventilate another section.

To provide dilution, the ventilation system must deliver 9,000 cubic feet of air per minute (cfm) to the last open cross cut of a set of developing entries and to the intake entries of a retreating section. The system must also supply 3,000 cfm to each working face where coal is being cut, mined or loaded.

Unless otherwise approved by the local enforcement official, the line brattice or face ventilation device must be maintained within 10 feet of the face. For exhausting face ventilation systems, the minimum mean entry air velocity in working places where coal is being cut, mined or loaded is 60 feet per minute (fpm).

Each coal mine operator must also submit for approval a ventilation system and methane and dust control plan. The plan must show in detail the methane and dust control practices along all haulageways and travelways, at all transfer points, at underground crushers and dumps, in all active working places and in any other areas which may be required by MSHA's local enforcement official.

Prior to approval, dust samples are collected by inspection personnel to verify system performance. The dust control plan concept was developed to provide flexibility, yet ensure that appropriate measures were being taken to control respirable dust. The following discussions provide more information on specific dust control systems used for various mining systems.

DUST CONTROL ON CONTINUOUS MINER SECTIONS

Approximately two-thirds of the mining sections in the United States utilize continuous mining machines. Continuous miners are used to both develop and retreat room and pillar mining sections. Dust generated on a drum type continuous miner is controlled by two primary means, ventilation and water. The two basic types of face ventilation are exhausting and blowing. In an exhausting ventilation system, air is brought to the face at a lower velocity, captures the dust cloud and then extracts it from the face at a higher velocity. For a blowing face ventilation system the return air passes over the mining machine. This situation necessitates the use of additional controls such as machine mounted dust collectors (scrubbers) to maintain adequate dust control.

Water sprays are used in addition to ventilation to suppress and direct the dust cloud generated at the face. Typical suppression sprays are mounted on the miner as close to the cutting drum and gathering arms as possible. These systems are designed to deliver water to strategic dusty locations around the machine. Directional sprays (spray fan systems) are mounted on the body of the miner up to 10 to 15 feet from the face. These sprays are designed to use the momentum of the water to direct the dust cloud away from the machine operator. Spray fan systems are normally used in conjunction with exhaust line brattice.

Each continuous mining section utilizes one or more roof bolters to install roof support in the entries mined. Dust control on roof bolters is especially important because the drilled strata can contain high levels of quartz. The two primary methods of controlling dust generated during roof bolting operations are through proper use and maintenance of the machine dust collection system and proper ventilation of the working place.

DUST CONTROL ON CONVENTIONAL MINING SECTIONS

In a conventional mining system the coal is extracted in a series of operations each performed in proper sequence. The operations in a conventional mining system are: cutting, drilling, blasting, loading and hauling. Each operation in the cycle employs a specialized piece of equipment to perform that operation.

The cutting operation is performed with a mobile cutting machine which most nearly resembles a large chain saw on wheels. Dust from the cutting operation is controlled by the use of a "wet" cutter bar and external water sprays mounted above the cutter bar as well as proper ventilation. The wet cutter bar is made by plumbing a water pipe inside the cutter bar which terminates in a small opening at the end of the bar. The movement of the cutting chain around the bar distributes the water along the length of the cut. External water sprays should be directed towards the ingoing and outgoing bits and also toward the pile of cuttings being deposited on the mine floor.

The drilling operation employs a mobile drilling machine with a single movable drill capable of drilling to the same depth as the cutting machine. The number of holes drilled depends on the height of the coal seam, width of the face, hardness of the coal and the desired size of the coal lumps. The period of highest dust concentration is when the drill is first sumped into the coal. Once the drill has penetrated the coal, the hole itself helps contain the dust. The use of a wet auger (drill steel) is the preferable method of controlling dust on a coal drill. Water is directed through the hollow auger to the bit and is then forced out of the hole after it has mixed with the cuttings and dust. The coal cuttings and dust are thoroughly wet and come out of the hole in the form of a slurry, thus producing very little dust.

Blasting is done chiefly with permissible explosives. An explosive charge is placed in each hole and then stemmed with an inert material (either water or clay dummies). The charges are wired together and then detonated. The rapid release of energy by the explosives breaks the coal and also generates a large amount of dust. However, the dust is rapidly dissipated if the face is properly ventilated. If the blasting is done on the return air side of the other mining operation, then personnel will not be exposed to the dust generated by blasting. The next operation is the loading of the coal by either a loading machine or a scoop. Loading machines have mechanical gathering arms which pull the coal onto a chain conveyor located along the centerline of the machine. The movement of the gathering arms and chain conveyor produces dust. This dust is controlled by the face ventilation system and by external water sprays mounted on the body of the loading machine. Prior to loading, the coal pile should be thoroughly wetted. Wetting the coal pile is particularly important since subsequent loading of the coal is done with scoops that are not equipped with water spray systems.

DUST CONTROL ON LONGWALL MINING SECTIONS

In general longwall mining systems in the United States use single or double drum shearers to retreat mine a block of coal. Longwall faces range from 400 to 1,000 feet wide with total panel length often in excess of 4,000 feet. There are approximately 100 operating longwalls which produce approximately 15 percent of the underground coal mined. Normally seven people are required to operate the longwall face equipment.

When identifying and attempting to control a longwall system's dust source(s), the longwall can be divided into three primary sources of dust generation. These sources are the machinery in the headgate area, the shearer and the shields.

The dust generated in the headgate area affects personnel on the entire longwall face since it contaminates the intake air before it traverses the face. The headgate sources are the stageloader, crusher and product transfer points. The common practice employed for dust control is to enclose the stageloader and crusher on the sides and top and to install flat jet water sprays across the product inlet and outlet. To assist the water sprays in creating a tighter enclosure on the product inlet and outlet, a strip of mine conveyor belting or brattice is installed on both ends. Usually flat jet water sprays are located in the crusher and along the length of the stageloader. To control dust at transfer points, various types of water sprays are used.

The shearer's primary dust source is the cutting of the coal by the bits on the drum(s). To combat this dust source, four control methods are normally used. The four dust control methods are: internal water sprays, external water sprays, remote control and work practices.

Internal water sprays are the water sprays in/on the shearer cutting drum. The internal sprays are used to suppress the dust at the source and provide a cooling effect for the cutting bits. The number of sprays range from 25 to 45 with the orifice ranging from 1/8 to 3/16-inch. The operating water pressure measured at the spray nozzle ranges from 40 to 100 pounds per square inch (psi).

The external water sprays are the water sprays located on the shearer body or on any attached bar and/or arm. The best practice is to use these sprays to direct the dust laden air over the shearer body so that the shearer operator is maintained in a clean split of intake air not contaminated by the dust generated by the shearer. The operating water pressure measured at the spray nozzle ranges from 40 to 120 psi. To assist the external water sprays in directing the dust, passive barriers (usually made of mine conveyor belting) are sometimes attached to the shearer body, bars and/or arms.

A remote control unit(s) is a device that allows the shearer operator(s) to control the shearer from various locations. It is used to remove the shearer operator(s) from the dust being generated by the shearer. Radio control or umbilical cord are the two types of remote control units available. Radio control is more versatile but not as durable as an umbilical cord unit. Approximately 50 percent of the shearers are equipped with a remote control system.

Administratively controlled work practices are also used on longwalls to lower the dust exposure of personnel. The most common work practice employed to lower exposure is to reduce the amount of time personnel spend on the face. This is accomplished by having personnel move to the upwind side of the shearer after they have completed their primary tasks. Also changing the cutting sequence of the shearer can reduce the exposure of face personnel. A common practice employed is to cut unidirectional, cutting two-thirds of the face height in one direction and cutting the remaining one-third coming back. The shields (roof supports) are then pulled on the upwind side of the shearer. This practice keeps the shield setters out of the dust that is created by the shearer. However, the shearer operators are exposed to the dust generated by the shields. Bidirectional cutting, cutting fullface height in both directions, exposes shield setters to the dust generated by the shearer for half the mining cycle and the shearer operators to the shield dust for half a mining cycle.

The movement of the shield top creates a dust problem because the crushed and ground material on top of the shield falls. The severity of the dust problem will vary depending on the amount of this falling material. The dust problem can range from negligible to very severe. To circumvent this problem, the industry is phasing in electrohydraulic shields. The electrohydraulic shields have controls connected to a computer on the shields that allow a set of shields (1 to 15) to be electronically controlled. This allows shield setters to achieve an upwind position from this dust source.

SUMMARY

Prior to the 1969 Act respirable dust levels of 9 mg/m^3 were commonly reported. Today the industry average exposure for the designated occupation is approximately 1.0 mg/m^3. These dust levels have been mainly achieved through the application of the various dust control methods previously discussed which include:

1. A supply of uncontaminated intake air.
2. Suppression through the use of machine cutting head design and water.
3. Containment through the use of properly designed and maintained face ventilation systems, water sprays or barriers.
4. Dilution from an adequate supply of fresh air.
5. Avoidance through the use of remotely operated cutting and loading machines.
6. Administratively controlled work practices.

With continued application of these techniques, respirable dust levels can be maintained at acceptable limits.

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PREFACE

It is truly an honor and privilege to provide this preface to the Proceedings of the Seventh International Pneumoconioses Conference which was conducted in Pittsburgh, Pennsylvania during August 23–26, 1988. This symposium, only the seventh such conference since 1930 and the first to be held in the United States, was conducted under the joint sponsorship of the International Labour Office (ILO), the National Institute for Occupational Safety and Health (NIOSH), the Mine Safety and Health Administration (MSHA), the Occupational Safety and Health Administration (OSHA), and the Bureau of Mines (BOM).

The Pittsburgh Conference was attended by over 1000 participants from 50 countries. The symposium call for papers was issued in 1987 and invited submission of abstracts focusing on research and scientific expertise on the pneumoconioses and other occupational respiratory disease. The response was truly gratifying and resulted in the acceptance of over 275 papers for presentation in various scientific sessions and workshops and 124 papers for presentation at poster sessions. The Proceedings (Part I) now in your hand contains over half of those presented at the Conference.

It is my pleasure to acknowledge with gratitude the invaluable assistance of the many individuals and organizations which contributed to the planning, conduct and follow-up of this Conference. The International Organizing Committee was extremely helpful in developing the framework of the Conference. Special thanks to the National Organizing Committee who generously gave of their time and talents so that this Conference was truly representative of an event of its preeminent stature. I wish to publicly thank Mr. John Pendergrass, Assistant Secretary of Labor, OSHA and Mr. David Taylor, Deputy Director General, ILO for their inspiring keynote presentations; to Dr. J. Donald Millar, Assistant Surgeon General, Director of the National Institute for Occupational Safety and Health, Mr. Lynn Williams, International President, United Steel Workers of America and Dr. Bruce Karrh, Vice President, Safety, Health and Environmental Affairs, E.I. Dupont de Nemours Co., USA for their incisive overview presentations; and to the many staff of NIOSH who worked tirelessly in the conduct of the Conference. All were important partners in this enterprise.

But there could have been no successful venture without the enthusiastic and committed support of two people. Dr. Jack Berberich who when called upon at a critical time served both as Executive Secretary-General of the Conference and Editor-in-Chief of these Proceedings and Mr. Georg Kliesch, ILO.

On behalf of the International and National Organizing Committees, the five sponsoring organizations, these Proceedings (Part I) are presented with the hope that you will find them as rewarding as your participation in the Conference. We look forward to completing Part II within the next 12 months so that you will have a complete chronology of the program.

Edward L. Baker, M.D., M.P.H.
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VIIth International Pneumoconioses Conference

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