INSTRUCTOR

DUST MANAGEMENT

PROTECTING YOUR HEALTH

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A Note to Instructors
The Dust Management: Protecting Your Health module highlights the health hazards and other dangers dust—and respirable dust, in particular—present in underground and surface mining, and it offers ways to manage dust effectively. As an instructor, you can choose to use all or parts of the material to suit your training needs or time constraints.

No matter how you design your training, this workbook offers a variety of options to enhance the training. For instance, at the end of the book are discussion scenarios designed to get learners to apply some of the concepts covered. You can choose one or two scenarios that might be appropriate for your audience, or perhaps you might want to create one of your own or ask participants to describe a similar situation they have faced at their mine. There also are additional review questions included should you want to further question learners on the materials in the Dust Management book.

It's important to note that this book includes a section on the continuous personal dust monitor (CPDM) that the Mine Safety and Health Administration (MSHA) proposed in 2010 as a requirement for every miner. At the time of this writing, MSHA's proposed rule requiring CPDMs and stricter dust standards is on hold. If you choose to skip this section, keep in mind that some of the discussion scenarios and optional review questions later deal with the proposed new regulations and the CPDM. You may want to include them anyway and have your miners focus on how those workers can reduce their exposure to respirable dust.

Disclaimer
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Dust Management

Among the many dangers you face as a miner, exposure to respirable dust generated from the mining process might carry the most serious long-term consequences. Chronic exposure to coal mine dust can lead to a series of respiratory illnesses called, collectively, black lung. You can die from these illnesses, and they have no cure. That's why regulations have been in place to monitor and control the dust you breathe. Still, new cases of black lung continue to develop; in fact, the incidence of black lung, especially in newer miners, has increased dramatically in recent years after three decades of improvement.

The Mine Safety and Health Administration (MSHA) in 2010 proposed two major regulations in support of its initiative to end black lung. One would cut in half the concentration of coal mine dust that you are allowed to breathe in during a typical shift. The other would require each miner to wear a continuous personal dust monitor (CPDM). At the time of this writing, both proposals are on hold.

A continuous personal dust monitor. The monitor is worn on your belt, and an intake valve next to the lamp collects the dust to be measured.

In this training you will learn what dust is, how you can try to control it, and what the readings on your personal dust monitor mean and how to respond to them. Then you will practice your skills in understanding the CPDM by taking part in a number of scenarios you might experience as a miner.

Objectives

Here are the objectives of the training:

Understand the health risks of long-term exposure to respirable dust.

Know what levels of dust exposure are acceptable by law and which thresholds indicate unacceptable levels.

Recognize the appropriate actions to take according to the level of dust exposure you face.

Grasp why options within the hierarchy of controls not only contribute to a safe workplace, but also help to protect your health in the short and long term.

What Is Dust?

Dust is everywhere, and sometimes it's even visible to the naked eye. It's in our homes, it's in our cars, it's outside when we walk down a street. When the wind blows across a dry, dirt-covered area outside the mine, you can really see it. All it takes is for something like that breeze to disturb the material that makes up the dust and send it flying. And it's those really small particles that endanger your health because you can breathe them in.

Dust is everywhere, but especially at mine sites.

Dust has a specific definition according to the Mine Safety and Health Administration:

> "Finely divided solids that may become airborne from the original state without any chemical or physical change other than fracture."

Simply put, dust is tiny solid particles formed from processes that grind, crush, or impact the original material and that are then carried by the air. The effects of dust depend on the original material—if the original material is hazardous, the dust will be hazardous. Dusts such as silica or asbestos are toxic and can cause cancer. However, any dust can become a health problem if large amounts are inhaled or if smaller amounts are inhaled over time. The latter is how black lung develops from coal dust.

The size of the dust particle is an important consideration. Some particles are so large, they settle almost immediately, while others remain in the air indefinitely. (Dust is measured in micrometers, also known as microns.) **REMEMBER: YOU MAY NOT BE ABLE TO SEE THE DUST THAT CAN HURT YOU!**

There are a few terms used to describe dust:

- **Respirable dust**—dust particles small enough to penetrate the nose, the upper respiratory system, and deep into the lungs. These particles stay in the body because they are too deep to be eliminated by the body's natural mechanisms, and they're the most dangerous because they can collect in the lungs. Most regulating agencies define 10 microns or smaller as the size of respirable dust.
- **Inhalable dust**—dust that is trapped in the nose, throat, and upper respiratory tract. Inhalable dust is 100 microns or smaller, but this dust can be eliminated by the body.
- **Total dust**—all the dust particles in the air, regardless of size or composition. It includes both inhalable and respirable fractions.
- **Nuisance dust**—this is also the total dust in the air, but is defined by the Occupational Safety and Health Administration (OSHA) as dust that contains less than one percent quartz. As a result, it is not considered harmful when exposure is kept below limits set by regulating agencies.

Instructor Note: Make sure that miners understand that they may not see the dust that can hurt them.

Consequences of Dust

Dust is pervasive. It can settle anywhere the air current takes it, including in your lungs. It can create conditions in which it's hard to see, making it unsafe for miners, especially around moving equipment. It can foul the equipment itself as the dust finds its way into the moving parts. And when concentrated enough, it can turn explosive.

An example of just how dangerous coal dust can become happened at the Upper Big Branch mining disaster in 2010 in which 29 miners were killed in West Virginia. State investigators determined that large amounts of coal dust lingering in the mine because of poor ventilation helped spread throughout the rest of the mine an explosion caused by a methane gas buildup. The coal dust acted like kerosene poured over the charcoal briquets of a barbecue. It propagated the explosion throughout the mine.

Health Risks

Not all dusts produce the same kinds of health hazards. Factors such as dust composition, concentration, particle size and shape, and miner exposure time determine how severe the effects will be.

Asbestos worker.

Health effects from dust exposure include:

- Occupational respiratory diseases. The general name for dust-related lung diseases is pneumoconiosis. Some serious work-related types of pneumoconiosis include:
    - **Black lung—**a lung disease caused by exposure to coal dust particles**.** It's often referred to as CWP—coal worker's pneumoconiosis.
    - **Silicosis—**a lung disease caused by exposure to the dust of quartz and other silicates. This is an irreversible lung disease that progresses even if you are removed from the silica exposure.
    - **Asbestosis—**a lung disease caused by asbestos fibers. This is also an irreversible lung disease.
- Irritation to eyes, ears, nose, throat, and skin.
- Emphysema, a severe breathing disorder.
- Bronchitis, an inflammation of the airways to the lungs.
- Chronic obstructive pulmonary disease (COPD), a progressive disease that makes it hard to breathe and which is marked by coughing that produces large amounts of mucus, wheezing, shortness of breath, chest tightness, and other symptoms.

The National Institute for Occupational Safety and Health (NIOSH) reports that **cases of black lung are increasing among coal miners**, according to recent data. Even younger miners are showing evidence of advanced lung disease caused by dust exposure. According to Dr. Lee Petsonk, a professor of medicine at West Virginia University who has studied and written about CWP for years, in 2003 statistics started to show an increase in CWP with miners who had fewer than 20 years' experience. Petsonk said miners used to have to spend at least 15 years underground before any evidence of black lung

Photos courtesy of the United Mine Workers of America.

appeared. In a 2011 presentation[1] Petsonk noted that silicosis is definitely increasing in miners, and that's contributing to the rise in CWP numbers. He believes a few factors may be contributing to the increases:

- The "easy" coal has been mined, and mining is now going after more difficult seams, which involves drilling through more rock. Drilling the rock unleashes silica dust, which is 20 times more toxic than basic coal dust.
- Longer shifts and extended work weeks have increased miners' exposure to dust. When you work 9- to 12-hour shifts, an increasingly common schedule across the industry, the lungs have less time between shifts to clear out before you return to the mine. In effect, the lungs can't expel everything, and the dust particles build up.
- Today's more effective mining equipment means more coal is accessed, increasing your exposure to coal dust.

The symptoms of CWP include cough (with or without mucus), wheezing, and shortness of breath (especially during exercise). In the early stages you may have no symptoms at all. X-rays of the lungs will show evidence of black lung. Simple CWP features small opaque spots on the X-ray. When those spots get larger and more widespread, the condition is called progressive massive fibrosis (PMF). The lungs become stiff, and they cannot expand fully. The normal exchange of oxygen and carbon dioxide is interfered with, and breathing becomes very difficult. Your lips and fingernails may have a bluish tinge, and you might retain fluids and have signs of heart failure.

> **Instructor Note:** Ask students if they work with or know anyone with these symptoms or if they have had symptoms themselves.

There is no specific therapy for these diseases. There isn't any treatment to cure them. That's why preventing them in the first place by reducing your exposure to dust is so important.

Remember too that you don't necessarily have to be an underground miner to be at risk for CWP. Workers in some aboveground operations, such as workers at preparation plants where crushing, sizing, washing, and blending of coal are performed and at tipples where coal is loaded into trucks, railroad cars, river barges, and ships also have increased exposure to coal dust. A 2012 NIOSH study of 2,300 strip miners found that about 2 percent of them tested positive for black lung, compared to 3.2 percent of underground miners.[2] The highest exposure, though, still comes for underground miners working at the face extracting the coal. Jobs such as longwall shearer operators, jack setters, and continuous miner operators have an especially high risk of exposure.

Silicosis is another lung disease characterized by fibrosis, where the lungs cannot expand fully. The main symptoms of silicosis are difficult or labored breathing and shortness of breath. The disease is caused by the inhalation, retention, and reaction of the lungs to crystalline silica. Respirable silica occurs in a variety of industries, and it also is extremely common naturally. It's often called quartz in nature and is in many rocks. Miners are potentially exposed to quartz dust when rock within or adjacent to the coal seams is cut, crushed, and transported. Other workers likely to be exposed to it are sandblasters, tunnel builders, silica millers, quarry workers, foundry workers, and ceramics and glass workers.

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[1] Dr. Lee Petsonk (2011, April 7). *Lung Health of U.S. Coal Miners in 2011: Problems and Solutions.* Presentation at the Mining Health and Safety International Symposium, Charleston, WV.

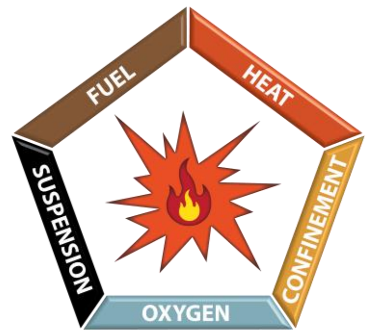
[2] Charleston Gazette (2012, June 18). *Study finds strip miners getting black lung. Retrieved from http://wvgazette.com/News/201206180157.*

Explosion Risk

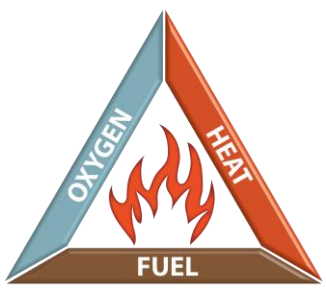
Coal dust and other types of dust can potentially explode in the right concentrations. Even materials that aren't flammable in their bulk state can combust when airborne as fine dust. That's one reason rock dust, usually limestone, is applied to the walls of coal mines. The addition of enough rock dust makes the entire mixture inert so that it can't explode. MSHA requires that all areas of a coal mine that can be safely traveled must be kept adequately rock dusted to within 40 feet of all working faces. In 2010 MSHA issued an emergency order increasing the percentage of rock dust and other inert substances that must be mixed with the coal dust to prevent methane explosions because recent samplings in deep mines show that the advanced mining equipment is generating much finer coal dust particles than those on which the original standards were based. The rock dust itself is safe for you because the kind used in mining is required to have less than 3 percent silica, which is within acceptable exposure limits.

Five factors (often called the "explosion pentagon") must be available for a dust explosion to occur:

- Fuel (ignitable dust)
- Ignition source (heat or electric spark)
- Oxidizer (oxygen in the air)
- Suspension of the dust into a cloud (in sufficient quantity and concentration)
- Confinement of the dust cloud



If any of the components is missing, the dust can't explode.



Fire is another risk when dust is involved. Dust can serve as the fuel, or combustible material, in the "fire triangle." The triangle is made up of the three factors necessary for a fire: **oxygen** to sustain combustion, **heat** to raise the material to its ignition temperature, and the **fuel.** The combination creates a chemical or exothermic reaction that is fire.

Instructor Note: Coal dust is a source of combustible material for coal dust explosions. Even a thin layer of additional coal dust deposited on an area previously rock dusted can result in an explosive condition.

Safety Risk

When you're working underground, imagine how a cloud of dust will reduce visibility even more in an area that's dim by nature. You already have to be aware of potential hazards, such as being struck by moving equipment or avoiding the moving parts of machinery such as conveyor belts or parts of a longwall miner. If excessive dust is present, it can be difficult to see around you and your equipment, increasing your safety risk.

Lots of dust reduces visibility in what already is a hazardous environment.

MSHA Dust Standards

The Mine Safety and Health Administration sets standards (see 30 CFR Part 70: Mandatory Health Standards—Underground Coal Mines and 30 CFR Part 71: Mandatory Health Standards—Surface Coal Mines and Surface Work Areas of Underground Coal Mines) for how much respirable dust you can be exposed to when you mine.

According to the regulations:

a) Each operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which each miner in the active workings of each mine is exposed at or below 2.0 milligrams of respirable dust per cubic meter of air.

b) Each operator shall continuously maintain the average concentration of respirable dust within 200 feet outby the working faces of each section in the intake airways at or below 1.0 milligrams of respirable dust per cubic meter of air.

c) If the air sample contains more than 5 percent quartz, the dust standard is further reduced. This is to prevent the development of silicosis.

> **Instructor Note:** If you want your class to be aware of how this reduced standard is calculated, give them the following information:
>
> The reduced standard is calculated by dividing 10 by the percentage of quartz in the sample. Look at the following examples to see this calculation:
>
> **Sample:** 10 percent quartz **Formula:** 10 ÷ 10% quartz = 1 mg/m^3 dust standard
> **Sample:** 8 percent quartz **Formula:** 10 ÷ 8% quartz = 1.25 mg/m^3 dust standard
> **Sample:** 6 percent quartz **Formula:** 10 ÷ 6% quartz = 1.67 mg/m^3 dust standard

Simply put, this means that over the course of a normal eight-hour shift in the working part of the mine (such as near the face), **the amount of dust you breathe in should not exceed 2.0 milligrams per cubic meter (mg/m^3)**, assuming the quartz level does not exceed 5 percent. In 2010 MSHA proposed making this standard twice as strict by changing it to 1.0 mg/m^3 over a shift.

Acceptable exposure to dust depends on the amount of quartz in the dust.

The second part of the current regulation already maintains the standard at 1.0 mg/m^3 farther away from the working part of the mine. The new proposal would change this standard to 0.5 mg/m^3.

The proposed regulations also cover the measurements for shifts longer than eight hours by creating a formula to convert the readings to the equivalent of an eight-hour shift. MSHA said the proposal is consistent with generally accepted industrial hygiene practices that adjust worker exposures to account for all time worked, recognizing that an extended work shift results in a shorter time to recover before the next exposure.

Under MSHA's existing standards mine operators are required to collect bimonthly respirable dust samples during a normal production shift and submit them to MSHA for analysis to determine compliance with respirable dust standards. MSHA defines normal production shift as a shift during which the amount of material produced is at least 50 percent of the average production reported for the last set of five valid samples or a production shift during which any amount of material is produced by a new mechanized mining unit, until a set of five valid samples is taken. If the samples don't meet the standards, the mine operator is issued a citation. The sampling person at the mine will continually monitor dust samples and determine what the proper limits are based on distance from the face and amount of quartz in the samples.

The continuous personal dust monitor that MSHA's proposed new regulations would require you to wear will give you a near real-time reading of how much respirable coal dust you've been exposed to over the course of your shift. The monitor will perform the previous calculations for you.

Instructor Note:
The 2.0 mg/m^3 standard is a time-weighted average (TWA) concentration of airborne toxic materials weighted for a certain time duration, usually eight hours. TWA exposure is a way to calculate your daily or full-shift average exposure.

The TWA formula is:

$$\frac{\text{(Measured Concentration x Hours Worked Within Concentration)}}{\text{8 hours}}$$

Here's an example of how TWA is calculated:

You know the TWA is 2.0 mg/m^3 for coal dust. Your personal dust monitor measures a concentration of coal dust at 1.0 mg/m^3 for the first two hours you work before you take a 15-minute break.

$$\frac{(1.0 \times 2)}{8} = \frac{2}{8} = .25\ mg/m^3$$

You're well within safety limits for the shift.

Now you're going to work another two hours before lunch, and the concentration is measured at 1.5 mg/m^3.

$$\frac{(1.0 \times 2) + (1.5 \times 2)}{8} = \frac{5}{8} = .625/m^3$$

You're still within limits for the shift. After lunch you're going to work another two hours before taking a 15-minute break. You work close to the face and get 2.0 mg/m^3.

$$\frac{(1.0 \times 2) + (1.5 \times 2) + (2.0 \times 2)}{8} = \frac{9}{8} = 1.125\ mg/m^3$$

You're still within limits. Now add another two hours at 3 mg/m^3.

$$\frac{(1.0 \times 2) + (1.5 \times 2) + (2.0 \times 2) + (3.0 \times 2)}{8} = \frac{15}{8} = 1.875\ mg/m^3$$

For your eight-hour shift you remained within your time-weighted average of 2.0 mg/m^3, even though the dust reached higher concentrations as the day went on. Work more than eight hours at this rate, though, and you may exceed the allowable TWA. The exposure examples assume you're not wearing a respirator. If you choose to wear one deemed appropriate for the conditions, then your exposure to the dust is greatly reduced.

Miners’ Rights and Mine Operators’ Responsibilities

As a miner, you are entitled to specific rights regarding dust, according to MSHA regulations. In addition, mine operators have a number of responsibilities toward ensuring a safe workplace regarding dust, based on MSHA regulations.

Miners Have the Right to:

- Air free of harmful levels of respirable coal mine dust.
- Training on:
    - Dust controls in the mine’s approved ventilation plan.
    - The sampling procedures required to accurately monitor dust levels.
- Dust controls in the mine’s ventilation plan operating as specified.
- See the operator’s dust sampling results (posted on mine bulletin board).
- NIOSH-approved respirators when working in excessive dust.
- Request an MSHA inspection when:
    - Excessive dust levels are suspected.
    - Required dust controls are not used or maintained.
    - The operator’s dust sampling is not done properly.

Mine Operator’s Responsibilities:

- Keep dust levels below standard on each shift, using environmental controls.
- Use and maintain all dust controls in the ventilation plan on every production shift.
- Perform on-shift examinations to ensure all required controls are in use and working properly.
- Conduct dust sampling under typical operating conditions by:
    - Properly maintaining sampling equipment, including cleaning and inspecting sampling head assemblies.
    - Following the regulatory requirements for proper collection of dust samples.
    - Taking dust samples bimonthly and submitting the required number of samples for testing.
    - Submitting samples that reflect dust conditions under normal work activities.
    - Not altering, opening, or tampering with dust samples.
    - Posting sample results on the mine bulletin board for 31 days.
- Make NIOSH-approved respirators available when excessive dust levels are present.
- Report to MSHA any status changes that affect dust sampling within three days.
- Train miners, at least annually, on:
    - The health hazards of breathing respirable coal mine dust.
    - The purpose of effective dust sampling and dust controls.
    - The mandatory health standards that apply to their mine.
    - The health provisions of the mine safety and health act.
    - The dust control portion of the approved ventilation plan.
- Emphasize the importance of participating in the NIOSH X-ray program.

Hierarchy of Controls

To best understand how you can deal with dust and reduce its danger, you first should be familiar with the hierarchy of controls. The hierarchy establishes an order in which hazards are dealt with logically.

The reasoning behind the hierarchy is simple—controlling your exposure to a hazard in the first place provides you the best protection. Think about it. It's far better to eliminate a hazard if you can. Barring that, then reducing your exposure to it is a good alternative.

Here's the common hierarchy of controls in order:

1. Elimination
2. Substitution
3. Engineering controls
4. Administrative controls
5. Personal protective equipment

The idea behind this hierarchy is that the control methods at the top of the list are potentially more effective and protective than those at the bottom, and they also can be cheaper. Following the hierarchy normally leads to putting in place inherently safer systems, ones where the risk of illness or injury has been substantially reduced.

Elimination and Substitution

Elimination and substitution are most effective at reducing hazards, but they also tend to be the most difficult to implement in an existing process. Let's face it, a continuous miner or longwall shearer is going to create coal dust. If you eliminated it from the mining operation, the dust would be greatly reduced, but you surely wouldn't mine much coal! Still, look for ways to eliminate hazards when you can or substitute for them.

Instructor Note: Ask your students what they might do to eliminate some risk from coal dust. One response might be to stand farther away from a piece of equipment that is creating dust. A few feet might reduce the amount of dust they inhale.

Engineering Controls

Engineering controls are used to remove a hazard or place a barrier between you and the hazard. Well-designed engineering controls can be highly effective in protecting you. They can cost more at first than administrative controls or personal protective equipment, but over time engineering controls frequently lower costs and in some instances save money in other areas of the process. They often are a good option in reducing mining dust and are a permanent fix to a problem.

Instructor Note: Ask your students for examples of engineering controls that reduce dust risk. Responses could include barriers, sprayers, and ventilation controls.

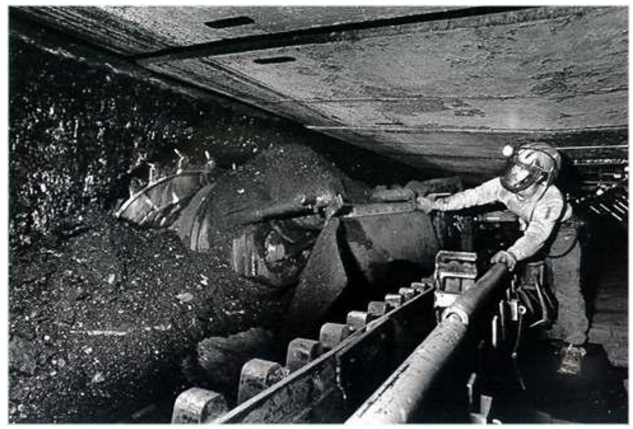
Administrative Controls

Administrative controls involve managing how the work is done and the mine operates. Those in charge of safety at a site can create processes and manage workers to reduce the hazards you face. MSHA mandates one administrative control in its own regulations: Miners who already qualify as having CWP symptoms have the option to exercise their rights to be placed in areas where they are exposed to lower levels of coal dust, but they are not required to do so.

Instructor Note: Ask your students for examples of administrative controls that reduce dust risk. Responses could include safe job procedures, rotation of workers, equipment safety inspections, and worker training.

Personal Protective Equipment

Consider personal protective equipment (PPE) your last option after engineering and administrative controls. While PPE can offer higher levels of individual protection, it has many disadvantages. It’s expensive to maintain, it’s often unwieldy, and it even can pose its own health risks to you, such as increasing your chance of heat stress and exhaustion. The typical piece of PPE in a dust situation is the respirator. But there's more to wearing a respirator than just opening one up from a box and strapping it on. It must be individually fitted annually. And you as the worker must maintain that fit and may be prevented from wearing facial hair. MSHA regulations (30 CFR 70.300) make clear that the use of respirators shall not be substituted for environmental control measures in the active workings of a mine. PPE is a last resort.



This longwall operator wears an air stream helmet, which provides filtered dust-free air under his face mask. Image copyright Earl Dotter, The Appalachian Chronicle, 1969-1999: The Photographs of Earl Dotter.

Controlling Dust

Dust control systems reduce adverse health effects and increase visibility on the job.

In mining there are three major approaches to controlling dust:

1. **Prevention.** Preventing dust in a mining operation is impossible. Dust is part of the job. However, looking for ways to reduce dust production when possible benefits everyone. It may be as simple as moving to a different location when operating a piece of machinery.
2. **Control systems.** A variety of options exist for controlling dust, depending on the type of mining operation in place (longwall, continuous, surface). They fall into major categories:
   - **Enclosure, curtain, brattice.** These options isolate the dust from you.
   - **Remote.** Some equipment can be operated remotely, placing you farther away from the face where the dust is being generated.
   - **Scrubber.** This technology reduces the amount of dust produced by taking dust particles out of the air.
   - **Wet dust suppression systems.** Sprays on longwall and continuous miners keep the dust down at the point of coal fracture and add moisture to reduce dust during transport.
   - **Water.** Water can be sprayed on the dust cloud to reduce the amount of dust in the air.
3. **Ventilation.** Uncontaminated fresh air is pumped in to dilute the dusty air. Ventilating air is the primary way of protecting workers from respirable dust in continuous mining.

Installing a ventilation curtain.

Each of the three main types of mining use dust control methods that can make for a safer workplace for you. Being familiar with some of these options may help you reduce the amount of respirable dust you encounter or may let you suggest to management ways to help everyone achieve MSHA's dust exposure standards.

Longwall Mining

According to NIOSH[3], longwall operations have had difficulty maintaining consistent compliance with the federal dust standard. Longwall workers can be exposed to respirable dust from multiple sources, including the intake entry, belt entry, stageloader/crusher, shearer, and shield advance. Here are some dust control technologies and suggestions to help reduce the dust from longwall mining:

Intake Roadways

- **Limit support activities during production shifts.** For example, deliver or unload supplies, move vehicles, or remove stoppings during nonproduction shifts.
- **Apply water or hydroscopic compounds to control road haulage dust.** Keeping the mine floor moist either with water or compounds that pull moisture from the air will keep dust levels down.
- **Use surfactants.** Soaps and detergents dissolve in water and help maintain the moisture content of intake roadways.

[3] The background, suggestions, and technologies highlighted in this section are from *Best Practices for Dust Control in Coal Mining,* NIOSH Information Circular 9517, published in 2010.

Belt Entry

- **Maintain belt.** Missing rollers, belt slippage, and worn belts can cause belt misalignment and lead to spills or worse, result in a fire!
- **Wet the coal during transport.** Less dust will be created when the coal is wetted at the face.
- **Clean belt by scraping and washing.** Materials stick to the belt over time and create dust when they are crushed at the head and tail roller.
- **Use a rotary brush to clean conveying side of belt.** A motor-driven rotary brush can clean the belt and reduce dust.
- **Wet dry belts.** Keeping the bottom belt (the nonconveying side) wet can significantly reduce dust from a dry belt when it returns from the dump point.

Headgate Entry, Including Stageloader/Crusher

- **Fully enclose the stageloader/crusher.** Recent NIOSH longwall surveys found that all stageloader/crushers were fully enclosed, but this was accomplished through various methods. Regardless, it’s important to maintain all seals and skirts to keep the dust in the enclosure.
- **Wet the coal in the crusher and stageloader area.** Low water pressure and high-volume sprays are the most effective.
- **Use scrubber technology in the stageloader/crusher area.** Scrubbers also create negative pressure within the enclosed stageloader/crusher, which minimizes dust from leaking out of any gaps.
- **Use high pressure water-powered scrubber.** This is an alternative to fan-powered scrubbers.
- **Install and maintain a gob curtain.** A gob curtain between the first shield support and the rib in the headgate entry can force the ventilating air to make a 90-degree turn down the longwall face instead of leaking into the gob. Maintaining the curtain, though, is essential to prevent voids where ventilating air can escape into the gob.

A gob curtain.

- **Position shearer operators outby as the headgate drum cuts into the headgate entry.** When the headgate drum cuts into the headgate entry, the drum is exposed to the primary airstream, picking up large quantities of respirable dust. Even though the cutout time is short, shearer operators can face dust levels of 20-30 mg/m^3. Moving outby the shearer headgate drum before the drum cuts into the entry greatly reduces that exposure and protects the operator from flying coal as well.
- **Install a wing or cutout curtain between the panel side rib and the stageloader.** The curtain directs the airflow around the drum, reducing the amount of dust picked up in the airstream.

Shearer

- **Ventilate the face.** The cutting action of the shearer is the primary dust source in longwall mining, and creating a healthy airflow across the face dilutes the dust.
- **Use drum-mounted water sprays.** These sprays apply water directly at the coal fracture, but care must be taken to make sure the spray isn’t too powerful, which can then carry respirable dust into the primary airflow, exposing the shearer operator.
- **Maintain the cutting drum bit.** A dull bit results in shallow cutting, which generates far more dust.

A spray system at work.

- **Use directional water spray systems.** Directional systems can act like small fans and move dust along the face.
- **Keep the headgate splitter arm parallel to the top of the shearer.** Maintaining the positions of the headgate splitter arm at parallel keeps dust from boiling out into the walkway.
- **Take advantage of shearer deflector plates.** Raised deflector plates can make the directional spray system more effective.

Shield

- **Spray systems.** When shields advance, they can be a significant source of dust for shearer operators. Spray systems on the canopy or on the underside of the canopy help contain the dust cloud near the headgate and tailgate drum areas.

Continuous Mining

The highest respirable dust concentrations on continuous mining operations come from two sources: the continuous miner and the roof bolter. Operators of continuous miners and roof bolters also are exposed to higher levels of silica because of cutting or drilling into rock.

The continuous mining machine obviously generates the most dust, and the operator of the machine has the most potential for inhaling respirable dust. Those downwind of the active mining also will be exposed to more dust. Here are some dust control technologies and other suggestions to help reduce the dust from continuous mining:

- **Water spray systems.** The water can be used as a suppression system or to redirect dust.
- **Flooded bed scrubbers.** Dust is captured at the face and carried through ductwork on the continuous miner. Eventually it passes through a filter panel and is discharged as cleaned air.
- **Bit type and wear.** Worn bits produce more dust and must be replaced.
- **Modified cutting method.** If roof rock must be cut, to create less respirable dust, cut the coal beneath the rock first, then back up the miner to cut the remaining rock. This method leaves the rock in place until it can be cut out to a free, unconfined space.
- **Blowing face ventilation.** Clean intake air is blown toward the face and sweeps dust-laden air toward the return entries.
- **Exhausting face ventilation.** Intake air is delivered to the face in the working entry, the air sweeps the face, and the dust-laden air is then drawn behind the return curtain or through the exhaust tubing to the return entries.

Roof bolt operators can be overexposed to dust from drilling itself, cleaning the dust collector, working with a dust collector that has been poorly maintained, or working downwind of the continuous miner. Here are some dust control technologies and other suggestions to help reduce dust exposure to the bolter operator:

- **Maintain the dust collector system.** Check hoses and gaskets for leaks, and check vacuum pressure at the drill head daily.
- **Clean the dust box.** Clean the main dust compartment frequently. Stay upwind when removing dust from the dust box.
- **Use dust collector bags.** The use of dust collector bags to contain dust in the main compartment allows you to easily remove dust from the main compartment and deposit it against the rib.
- **Remove and replace the canister filter.** Reusing the filter is no longer recommended.
- **Clean the discharge side of the collector.** Removing and cleaning contaminated components downstream of the canister filter results in major improvements in dust and silica levels emitted from the collector’s discharge.

- **Install a sock on precleaners.** Roof bolters with dust collector precleaners that remove larger cuttings from the airstream before reaching the collector box often drop the cuttings to the mine floor in an unconfined manner. A sock made from brattice or rubber belting can be attached as an extension to the chute to minimize how far the dust falls unconfined.
- **Use dust hog bits.** These bits have a collection port in the bit body and work better at capturing drill dust than shank bits.
- **Work upwind.** Regardless of the type of ventilation being used, design the cutting sequence to limit the amount of time the bolter works downwind of the continuous miner.

Instructor note: Tell your students that about 25 percent of a continuous miner's quartz dust exposure can be from bolting operations. If you can plan your cuts and use proper ventilation, you can reduce your need to work downwind to reduce dust risk.

- **Consider wet drilling/mist drilling.** Unfortunately, wet drilling creates difficult working conditions for operators.
- **Route miner-generated dust to the return via collapsible tubing.** This is the simplest, most effective technique for controlling respirable dust downwind of the continuous miner on sections that ventilate with exhausting auxiliary fans.

Intake air is required to have a lower concentration of respirable dust (1 mg/m^3) than working in the mine. Maintaining that level is not usually difficult, but certain activities—delivery of supplies and personnel, parking equipment in intake, rock dusting, scoop activity, and construction—can briefly raise those levels. **Here are some strategies for keeping intake dust levels low:**

- Demonstrate good housekeeping to keep intake entries free of debris, equipment, and supplies.
- Perform activities such as supply delivery, scoop activity, construction, and rock dusting during nonproduction shifts.
- Keep haulage roadways damp.
- Park equipment in crosscuts to keep main airways obstruction free.

Surface Mines

Working above ground poses a serious dust risk to your health in the form of crystalline silica dust, which is released when rocks are drilled. Overexposure to silica dust can lead to silicosis, a potentially fatal lung disease. The mining machine operator is the occupation most commonly associated with the disease. Operators of drills, bulldozers, scrapers, front-end loaders, haul trucks, and crushers often are exposed to more than the respirable dust standard. Here are some approaches for managing dust exposure in surface operations:

Surface mines present their own dust hazards.

- **Maintain an effective dust collection system for drill dust, which is generated by compressed air flushing the drill cuttings from the hole.** A dry dust collection system is typically used because it works in freezing temperatures, unlike wet suppression systems.
- **Maintain the enclosed cab filtration system in place for most operators of mobile equipment.** Ensure there is good cab enclosure integrity to keep the cab positively pressurized against wind penetration.

Use high-efficiency dust filters on the intake air supply into the cab. Use an efficient respirable dust recirculation filter. The doors should also be kept closed during operation, and the cab kept clean.

- **Treat haul roads.** Wetting roads with water or treating them with chemicals can keep down dust.
- **Increase the distance between vehicles traveling the haul road.** Greater spacing allows the dust kicked up by the first vehicle to settle and dissipate.
- **Enclose the primary hopper dump.** Staging curtains, for instance, can break up the natural tendency for dust to billow out of the primary dump hopper when a large volume of product is dumped in a very short time.
- **Use water sprays to suppress the dust in the enclosure.** Wetting the materials can keep down dust.
- **Use a water spray system to prevent dust from rolling back under the dump vehicle.** The water will keep the dust from rolling under the dumping mechanism into the hopper.

Instructor Note: If your mine does not have personal dust monitors, you may want to skip this part of the lesson with your miners. You can always add this section for review or training if your mine provides dust monitors and you need to train miners in their use.

You may also want to skip this section if your mine already has personal dust monitors and you know that your miners are competent in their use.

Monitoring for Dust

Current MSHA regulations require a mine operator to take one valid respirable dust sample from each designated area in the mine during a production shift once every two months. If the sample exceeds the respirable dust standard, then the operator must take five samples within a 15-day period from the designated area. Citations can follow until the violations are abated. The designated sampling areas are indicated on the mine's ventilation plan.

The Thermo Fisher Scientific PDM 3600 continuous personal dust monitor.

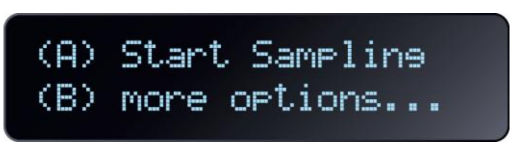
The changes proposed in 2010 would add another layer of sampling with the requirement that each miner wear a continuous personal dust monitor. The CPDM adds a nearly real-time element to the monitoring. With this change miners can see via the readings on the CPDM how much respirable dust they have been exposed to during the course of their shift. It's important to understand that the monitor is only nearly real time. You won't be able to flip a switch and see how much respirable dust you are being exposed to at the exact moment; instead, the monitor can display a sample of the air you've breathed over the last 30-minute sampling period or during the course of the shift. You can then use that information to determine whether you need to take some dust control action.

Understanding the CPDM

At the time of this writing, MSHA had approved one continuous personal dust monitor, the Thermo Fisher Scientific PDM 3600. The device uses a particulate monitor to measure respirable coal dust mass concentration, shift exposure, and accumulated exposure. Let's look at sample screens to see the information the monitor will provide you.

Start Sampling Screen

The Start Sampling screen contains the following information:



- **(A) Start Sampling.** This field contains directions on how to start a manual sample run. When in the Start Sampling screen, press the "A" button to begin the sample run.
- **(B) more options...** This field contains directions on how to exit the Start Sampling screen.

The PDM will allow you to stick with a preprogrammed sample or to start a manual sample on your own. The unit displays several screens during a sample run. Information includes cumulative exposure and other data as well as whether the instrument is operating properly.

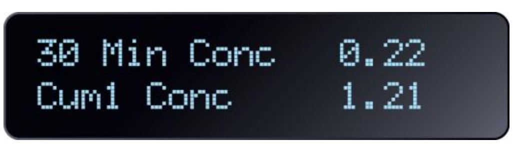
Warming Screen

The Warming screen contains the following information:

- **Wearer ID 477.** This field contains an 8-digit user identification number.
- **Warming: 028:07.** This field contains the time countdown (minutes:seconds) of the PDM unit’s warm-up time duration before the unit starts a first primary sample run. At the end of the warm-up time, the PDM will automatically begin running a first primary sample run and display the First Sample - Screen #1.

First Sample - Screen #1

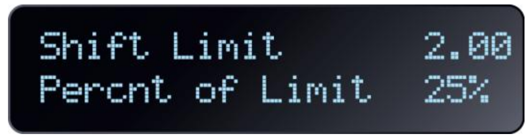
First Sample - Screen #1 will display automatically when the warm-up time duration for the first primary sample has completed. This screen contains the following information:



- **30 Min Conc.** This field contains the mass concentration value (mg/m^3) averaged during the previous 30-minute period.
- **Cum1 Conc.** This field contains the cumulative mass concentration value (mg/m^3) measured from the beginning of the first primary sample run.

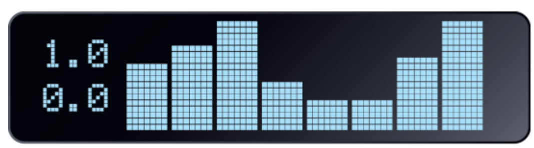
First Sample - Screen #2

First Sample - Screen #2 displays the shift mass concentration limit (mg/m^3)—**Shift Limit**—for the shift for the first primary sample run. **Percnt of Limit** is the percentage of exposure limit for the first primary sample run.



First Sample - Screen #3

The First Sample - Screen #3 displays a bar graph of the mass concentration (mg/m^3) collected during the entire primary sample run. When in the First Sample - Screen #1, press the “B” button to display the First Sample - Screen #3. Each bar represents the previous 30-minute, averaged mass concentration value. The "1.0” denotes the highest mass concentration value measured; the “0.0” represents the lowest mass concentration value measured. A new bar is added to the graph every 30 minutes, with the width of each bar representing a 30-minute time period. When there are bars displayed across the entire screen and a new bar is added, the new bar will display at the far right side of the screen, and the previously displayed bars will move to the left.



First Sample - Screen #4

The First Sample - Screen #4 displays the following information:

- **Elapsed Time: 001:15.** This field contains the elapsed sample time (hours:minutes) measured from the beginning of the first primary sample run.
- **Program Time: 008:00.** This field contains the entire sample time duration (hours:minutes) that was set by the user in the Start Sample screen for the first primary sample run.

Sampling Complete Screen

The Sampling Complete - Screen #1 displays the sample time duration and the total mass concentration (EOS) for the first primary sample run ("Sample 1"). The Sampling Complete - Screen #1 automatically displays at the end of a primary sample run.

The Sampling Complete Screen #1 contains the following information:

- **DONE: 08:00.** This field contains the entire sample time duration (minutes:seconds) for the first primary sample run.
- **EOS: 1.75.** This field contains the total mass concentration value (mg/m^3) measured from the beginning of the first primary sample run.

Review Questions

1. Which of the following factors determine how severe the health hazards of dust are?

    a. Dust composition
    b. Concentration
    c. Exposure time
    d. All of the above

2. If you are exposed long term to rock cutting in mines where quartz dust is released, you are at risk for this lung disease:

    a. Black lung
    b. Asbestosis
    c. Silicosis
    d. COPD

3. Is the following statement true or false?

    The majority of serious lung diseases that miners can develop from dust exposure are irreversible. **True**

4. Is the following statement true or false?

    Someone working in above ground mining operation has little chance of developing black lung. **False. Exposure to coal dust particles can occur just as significantly above ground as below.**

5. Which two factors along with suspension of the dust into a cloud, confinement of the dust cloud, and fuel must also be present for a dust explosion?

    a. Rock dust and heat
    b. Oxygen and carbon dioxide
    c. Oxygen and a spark, either electric or from a dull drill bit
    d. Temperature below 45 degrees F and ignitable dust

6. Which of the following jobs have an especially high risk for dust exposure?

    a. Longwall shearer operator
    b. Continuous miner operator
    c. Jack setter or roof bolter
    d. All of these jobs are high risk.

7. Assuming quartz content of less than 5 percent, MSHA's standard for respirable dust exposure is how many milligrams of respirable dust per cubic meter of air during a shift within the mine atmosphere?

    a. .5
    b. 1.0
    c. 1.5
    d. 2.0

8. Assuming quartz content of less than 5 percent, MSHA's standard for respirable dust exposure is how many milligrams of respirable dust per cubic meter of air during a shift within 200 feet outby the working faces of each section in the intake airways?

   a. .5
   b. 1.0
   c. 1.5
   d. 2.0

9. Under current regulations how often is the mine operator required to provide dust samples to MSHA for analysis?

   a. Twice a month
   b. Six times a year
   c. Once a month
   d. Once a quarter

10. Name the three major approaches to dust control:

   a. Prevention, control systems, ventilation
   b. Water, scrubbers, and curtains
   c. Longwall mining, continuous mining, surface mining
   d. Rock dust, continuous personal dust monitors, working upwind

> **Instructor Note:** The following questions cover other topics from this module but may refer to sections you might not have included. Feel free to use any or all of them.

Optional Questions

11. Is the following statement true or false?

   Dust is defined as finely divided solids that may become airborne from the original state without any chemical or physical change other than fracture. **True**

12. This class of dust involves particles that are big enough to penetrate the nose, throat, or upper respiratory tract, but big enough that the body can eliminate them:

   a. Nuisance dust
   b. Inhalable dust
   c. Respirable dust
   d. Silica

13. Dust is measured in:

    a. Millimeters
    b. Joules
    c. Cubic centimeters
    d. Microns

14. Coal worker's pneumoconiosis (CWP) is often called:

    a. Black lung
    b. Asbestosis
    c. Silicosis
    d. COPD

15. Assuming quartz content of less than 5 percent, MSHA's 2010 proposed standard for respirable dust exposure is how many milligrams of respirable dust per cubic meter of air during a shift within the mine atmosphere?

    a. .5
    b. 1.0
    c. 1.5
    d. 2.0

16. Assuming quartz content of less than 5 percent, MSHA's 2010 proposed standard for respirable dust exposure is how many milligrams of respirable dust per cubic meter of air during a shift within 200 feet outby the working faces of each section in the intake airways?

    a. .5
    b. 1.0
    c. 1.5
    d. 2.0

17. Reorder the hierarchy of controls below from most preferred (1) to least preferred (5):

a. Administrative	1 **(c) elimination**
b. Personal protective equipment	2 **(e) substitution**
c. Elimination	3 **(d) engineering**
d. Engineering	4 **(a) administrative**
e. Substitution	5 **(b) personal protective equipment**

18. These two controls from the hierarchy of controls are the most effective at reducing hazards but the most difficult to implement in an existing process:

    a. Administrative and elimination
    b. Engineering and substitution
    c. PPE and elimination
    d. Substitution and elimination
    e. Substitution and engineering

19. Barriers, sprayers, and ventilation are examples of this type of control:

    a. Elimination
    b. Engineering
    c. PPE
    d. Substitution
    e. Administrative

20. Moving a miner with CWP symptoms to a different location in the mine is an example of this type of control:

    a. PPE
    b. Substitution
    c. Elimination
    d. Engineering
    e. Administrative

21. Is the following statement true or false?

    PPE is a relatively cheap, easy, and effective option for providing miners the best protection against dust exposure. **False. It can be effective, but it's often neither cheap, nor easy.**

22. Is the following statement true or false?

    If all the controls are in place and working effectively in an underground mine, there shouldn't be any dust created. **False. Dust will always be created in mining.**

23. Which parts of the longwall operation are likely to expose miners to respirable dust?

    a. Intake entry
    b. Belt entry
    c. Stageloader/Crusher
    d. Shearer
    e. All of the above

24. Which of the following is a good idea for managing the dust created by the shearer in a longwall operation?

    a. Use surfactants on the intake entry.
    b. Ventilate the face.
    c. Keep the bottom belt wet.

25. When cleaning the dust box on a continuous miner, is it better to work upwind or downwind when removing dust from the dust box?

    a. Upwind
    b. Downwind
    c. Does not matter

26. Is the following statement true or false?

    Because surface miners don't face the enclosed atmosphere of an underground mine, they face minimal amounts of dust. **False. Surface miners face a serious risk from crystalline silica dust, which is released when rocks are drilled**

27. Is the following statement true or false?

    Applying an administrative control, such as increasing the distance between vehicles traveling the haul road at a surface mine, will reduce exposure to dust. **True.**

28. Does a continuous personal dust monitor provide you with a real time reading of the respirable dust you are being exposed to at that moment?

    a. Yes
    b. No

29. Which of the following does a continuous personal dust monitor not measure?

    a. Coal dust mass concentration
    b. Nonrespirable dust particles accumulated
    c. Shift exposure
    d. Accumulated exposure

30. In what ways does a continuous personal dust monitor differ from the area sampling currently required by MSHA?

    a. Measures an individual worker's exposure to respirable dust
    b. Eliminates samples having to be sent to an MSHA office for reading
    c. Provides nearly real-time readings of dust exposure
    d. All of the above

Discussion Scenarios

> **Instructor Note:** Scenarios 1, 2, 4, and 5 refer to readings from a continuous personal dust monitor. You can explain to your miners that while they may never use one of the monitors, they can still use the scenario to think about ways to manage their intake of respirable dust during a shift.

Scenario 1

You are working in a longwall mine, doing electrical work. You are six hours into your shift. As you move near the face, you can hear the longwall miner and notice an increase in dust levels as indicated by a low visibility. You look at your PDM and see that it reads:

You need to wire up a new junction box that will feed into a new section. A crew of miners are waiting for you to complete your task. To get to your worksite, you can either continue the direction you are headed, which will take you close to the face, or you can take a detour that will take an additional 10 minutes. What is the best course?

With two hours left in the shift, your cumulative concentration is starting to near the shift limit. Walking close to the face will certainly place you in an area of higher dust concentration. The detour is your best course for ensuring that your concentration of respirable dust you inhale over the shift remains at an acceptable level.

Scenario 2

You are in charge of a crew whose job is to move a series of ATRS (automated temporary roof support) machines from an older section to a newer section nearer the face. One of your crew is a red hat who appears overly cautious about almost everything. In one area near you, a coal mucker is creating a fair amount of dust. The red hat constantly checks his PDM, which shows a cumulative concentration of 1.25 mg/m^3. There are three hours left in the shift. What might you tell the red hat about his concerns about the dust near the coal mucker.

The red hat might be concerned about inhaling too much dust working near the mucker. You can reassure him that the PDM readings show that he is well within the 2.0 mg/m^3 shift limit, so even though the next couple of hours might involve working in dustier conditions, the PDM will give him near real-time monitoring of the respirable dust he has inhaled. Should the readings approach the shift limit, you can move the red hat farther from the coal mucker.

Scenario 3

You work at a preparation plant where coal is crushed, sized, washed, and blended before it is loaded into rail cars. While the plant attempts to keep dust to a minimum, there are some places that are always dusty, such as the intake dock. You have just been assigned to reduce dust levels at the intake dock. What ideas do you have?

Possible recommendations might include:

- *Keep the area free of debris, equipment, and supplies to allow for better ventilation.*

- *Perform activities such as supply delivery, scoop activity, and construction on shifts when the plant is not prepping coal.*
- *Keep haulage roadways around the intake dock damp.*

Scenario 4

For this scenario assume that you are working under the proposed 2010 respirable dust standards of 1.0 mg/m^3 in the mine atmosphere, and silica levels are acceptable.

You are a miner in an area of the highest exposure, at the face extracting the coal. Your job is to operate a longwall shearer. As you arrive at the face to begin your shift, your first sampling on your PDM shows a cumulative concentration of .25 mg/m^3 after an hour. You have discussed with the shearer operator on the previous shift that it seems like the cutting drum bits on the shearer might be due for sharpening or replacement.

After two hours of working close to the shearer, your cumulative concentration on your PDM shows .75 mg/m^3. You typically follow the readings on your PDM closely, and you normally wouldn't have accumulated this much exposure this early in the shift. You have been working close to the shearer so you could better judge how well it is cutting. During the last half hour you ran a sample to check your dust exposure, and you had a reading of 1.5 mg/m^3 for that sample run, again higher than normal.

Now that you've judged that the bits need changed and the water sprays also need cleaned or replaced, you are faced with a choice:

1. Stop the shearer now to change the bits and clean or replace the water sprays.
2. Continue the mining but look for ways to reduce your dust exposure.

You want to make the decision keeping in mind your own dust exposure and your supervisor's concern that you not exceed the shift limits for respirable dust exposure. Which choice do you think is best?

Answer:

1. *You chose to stop the shearer now. It will be down for two hours. Production will be lost. However, your cumulative dust exposure after five hours is now .87 mg/m^3.*
2. *You chose to continue the mining, but you changed your position and moved farther away from the shearer and upwind as well. Your cumulative concentration after five hours is now .92 mg/m^3.*

You now have another choice. You have to maneuver the headgate drum into the headgate entry. Which choice do you think is best?

1. You operate the shearer from your inby position for this 10-minute operation.
2. You move outby the shearer headgate drum before the drum cuts into the entry.

Answer:

1. *When the headgate drum cuts into the headgate entry, the drum is exposed to the primary airstream, picking up large quantities of respirable dust. Even though the cutout time is short, shearer operators can face dust levels of 20-30 mg/m^3. By operating the shearer from your inby position, your cumulative concentration an hour later when you leave the longwall miner is 1.10 mg/m^3. You have exceeded the new 2010 exposure standards.*
2. *When the headgate drum cuts into the headgate entry, the drum is exposed to the primary airstream, picking up large quantities of respirable dust. Even though the cutout time is short, shearer operators can face dust levels of 20-30 mg/m^3. Moving outby the shearer headgate drum before the drum cuts into the*

entry greatly reduces that exposure and protects the operator from flying coal as well. Your cumulative concentration an hour later when you leave the longwall miner is .97 mg/m^3. You have stayed within the new 2010 exposure standards.

Scenario 5

For this scenario assume that you are working under the proposed 2010 respirable dust standards of 1.0 mg/m^3 in the mine atmosphere, and silica levels are acceptable.

You are a roof bolter working alongside a continuous mining machine. You must work on the return side of the continuous miner during part of the production cycle. That means working downwind of the miner, and you know the respirable dust levels will be higher there. Your cumulative concentration after six hours underground is .70 mg/m^3, and you're now about to move to the return side. What can you do or what controls can be in place to ensure that your cumulative concentration doesn't exceed the limit for the rest of your shift?

There are a few possible options that you might try to keep your cumulative concentration down:

- *Work upwind.*
- *Maintain the dust collector system.*
- *Clean the dust box.*
- *Use dust collector bags.*
- *Remove and replace the canister filter.*
- *Clean the discharge side of the collector.*
- *Install a sock on precleaner.*
- *Use dust hog bits.*
- *Consider wet drilling/mist drilling.*
- *Route miner-generated dust to the return via collapsible tubing.*

Also keep in mind these and any other stipulations that may be unique to your particular mine should be addressed in the ventilation and dust control plan. The plan would also contain an approved cut cycle that would limit the amount of time a roof bolter would be working downwind.

Glossary

asbestosis—irreversible lung disease caused by exposure to asbestos fibers.

black lung—a series of respiratory illnesses caused by exposure to coal dust particles; often referred to as CWP—coal worker's pneumoconiosis.

continuous personal dust monitor (CPDM)—a device worn by the miner to provide near real-time measurements of the respirable dust inhaled during a work shift.

CWP—coal worker's pneumoconiosis; see black lung.

dust—according to MSHA: "finely divided solids that may become airborne from the original state without any chemical or physical change other than fracture."

hierarchy of controls—an order in which hazards are dealt with logically. The controls in order from most preferred to least are elimination, substitution, engineering, administrative, and personal protective equipment.

inhalable dust—dust that is trapped in the nose, throat, and upper respiratory tract, but which can be eliminated by the body; 100 microns or smaller.

microns—micrometers, the unit used to measure the size of dust particles.

nuisance dust—also the total dust in the air, but defined by OSHA as dust that contains less than one percent quartz, thus not considered harmful when exposure is kept below limits set by regulating agencies.

respirable dust—dust particles small enough to penetrate the nose, the upper respiratory system, and deep into the lungs and remain there; most regulating agencies define as 10 microns or smaller.

silicosis—irreversible lung disease caused by exposure to the dust of quartz and other silicates.

time-weighted average (TWA)—a way to calculate your daily or full-shift average exposure of airborne toxic materials weighted for a certain time duration, usually eight hours.

total dust—all the dust particles in the air, regardless of size or composition.

Supplemental Resources

Best Practices for Dust Control in Coal Mining

NIOSH Information Circular 9517
http://www.cdc.gov/niosh/mining/works/coversheet861.html

National Center for Health Statistics

Malignant mesothelioma: Age-adjusted death rates by state, U.S. residents age 15 and over, 1999-2005
http://www2.cdc.gov/drds/worldreportdata/FigureTableDetails.asp?FigureTableID=890&GroupRefNumber=F07-02

Coal workers' pneumoconiosis: Age-adjusted death rates by state, U.S. residents age 15 and over, 1996-2005
http://www2.cdc.gov/drds/worldreportdata/FigureTableDetails.asp?FigureTableID=510&GroupRefNumber=F02-02

Coal workers' pneumoconiosis: Age-adjusted death rates by county, U.S. residents age 15 and over, 1995-2004
http://www2.cdc.gov/drds/worldreportdata/FigureTableDetails.asp?FigureTableID=521&GroupRefNumber=F02-03b

Coal workers' pneumoconiosis: Number of deaths by rates by state, U.S. residents age 15 and over, 1996-2005
http://www2.cdc.gov/drds/worldreportdata/FigureTableDetails.asp?FigureTableID=514&GroupRefNumber=T02-04

Coal workers' pneumoconiosis: Most frequently recorded industries on death certificate, U.S. residents age 15 and over, selected states and years, 1990-1999
http://www2.cdc.gov/drds/worldreportdata/FigureTableDetails.asp?FigureTableID=29&GroupRefNumber=T02-06

Coal Workers' Pneumoconiosis Data from NIOSH Coal Workers' X-ray Surveillance Program

Percentage of examined underground miners with coal workers' pneumoconiosis (ILO category 1/0+) by tenure in mining, 1970-2009
http://www2.cdc.gov/drds/worldreportdata/FigureTableDetails.asp?FigureTableID=2549&GroupRefNumber=F02-046

United Mine Workers of America Health and Safety on the Job

Black lung image
http://www.umwa.org/?q=content/black-lung

CET
Center for Educational Technologies®

WHEELING
JESUIT UNIVERSITY