How to Control Dust

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By
Mark Kestner, Ph. D.
“Dr. Dust”

7 Hampshire Drive                  Mendham, NJ 07945
www.drdust.com

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GOOD DUST CONTROL = GOOD PROCESS CONTROL

Good dust control and good process control are two sides of the same coin. By combining good operating and engineering practices with properly designed wet suppression and dry collection systems, it is possible to comply with air quality standards and improve productivity.

BEFORE

AFTER
Developing a Dust Control Plan

- **Conduct a Site Survey** – listing all the dust sources on the property

- **Estimate Uncontrolled Dust Emissions** – using EPA AP-42, “Compilation of Emission Factors”

- **Specify RACM** – appropriate for your facility for each source.

- **Estimate Controlled Dust Emissions** – set a goal for control efficiency.

- **Establish a Budget** – use least expensive controls first.

- **Implement the Plan** – with accountability for results.

- **Monitor Performance** – keep dust and $$ under control with records to verify compliance with air standards and budgets.
**Dust Sources**

- **UNPAVED ROADS** - Produce dust by the action of tires on surface silt.
- **PAVED ROADS** – Carryout of silt onto paved surface becomes airborne
- **PILES** – Wind erosion, stacking and reclaim operations produce emissions
- **MATERIAL HANDLING** – Processing operations like crushing, screening and conveying all produce visible dust.
Reasonably Available Control Measures

- **Operational Controls**: Train operators to minimize dust. Speed control is a good example.
- **Engineered Controls**: Enclosing and containing dust sources can often be done with in-house labor and material.
- **Wet Suppression Systems**: Water is the most common dust suppressant to control dust from roads, piles and processing.
- **Collection Systems**: Baghouses, cyclones and other collection devices are high efficiency and may be the only alternative for hazardous or reactive dusts.

Use the least expensive controls first!
RACM for Paved Roads at Surface Mines

• **Housekeeping** – Clean up spills promptly.

• **Prevent Carryout** - from unpaved roads
  - Restrict access from unpaved routes
  - Rumble grates to loosen and remove rock
  - Wheel washes clean truck tires before they enter paved surface

• **Mechanical sweeping** – Brooms are not very effective unless road is watered first. Dry sweeping may actually aggravate visible dust emissions.

• **Flushing** – washes silt from surface. Can be done manually for small areas like plant entrance or by mobile tanker for entire route.

• **Vacuum Sweeping** – most effective in removing silt. Use a wet vacuum sweeper with spray nozzles in front of the brooms to avoid visible dust. Vacuum sweeping may be the only alternative in freezing weather

EPA Recommendation: Wet vacuum and flush for highest control efficiency.
Wheel washes keep paved roads clean

• Basins – Vehicles drive through a flooded basin. Require frequent cleaning to keep rock and silt from accumulating.

• Pressurized spray – Vehicles drive through a wash zone using water sprays at 40 to 200 psi. Water drains to storm sewer, collection basin or pond.

Important: Locate the wheel wash at transition from unpaved to paved surface. Set back 1000 ft. to allow tires to dry before they travel onto public roads.
RACM for Unpaved Roads
(Surface and Underground)

- **Speed Control** – low speed means less dust. For haul vehicles, keep speeds just high enough to maintain production. 15 mph for all others.
- **Housekeeping** – Clean up spills promptly by flushing or sweeping.
- **Shorten routes** – Less vehicle-miles traveled means less dust.
- **Proper Gradation** – Too much silt on the surface means more dust. Put down chips or larger aggregate to decrease the percentage of surface silt.
- **Dust Suppressants** – Used to stabilize the surface
  - Water – Low cost but evaporates
  - Surfactants – Help water to penetrate faster
  - Brines – Help unpaved surface retain moisture
  - Binders – Chemicals like lignins, latex, and cutback asphalt emulsions create a new surface. May require scarification and compaction.
- **Paving** – Most effective way to prevent dust but only if kept clean. Not feasible for most haul roads and stockyards.
Dust from unpaved roads may account for more than 30% of the total emissions from the property. Higher silt contents and vehicle speeds increase visible dust.
Watering is the most common method of unpaved road dust control. Use chemicals only if they reduce the frequency of treatment to the point where they become more cost-effective than watering.
RACM for Piles at Surface Operations

- **Methods to Protect Pile Surface**
  - **Training** – Instruct operators to minimize dust.
  - **Minimize Pile Height** – Piles over 10 meters high are exposed to the “winds aloft” and more susceptible to wind erosion.
  - **Smooth Pile Topography** – harder for wind to entrain dust
  - **Shelter Pile from the wind** – in-pit or on lee side of hill/berm.
  - **Wind Screens and Barricades** – screens reduce wind speed across the pile while barricades push wind up and over pile.

- **Methods to Stabilize Pile Surface**
  - **Watering** – control efficiency est’d at 50% depending on evaporation rate and frequency of application.
  - **Chemical Suppressants** – form a crust that resists wind erosion. Suppressants used for haul roads are also used for piles.
Stacking material into piles can cause visible dust. Dryer and finer materials produce more emissions.
Wind erosion blows fines from the surface which destabilizes larger lumps that roll to the base of the pile exposing fresh surface to the wind.
Aerial water cannons wet down pile surfaces to protect them from wind erosion. Automate to spray on a timed cycle to optimize water consumption.
A water tanker with a cannon can not only water or flush road surfaces but also wet down piles and wash down the plant superstructure.
Axial fans equipped with fine spray nozzles can be used to control dust from piles and work areas.
RACM for Material Handling and Processing at Metal and Non-Metal Surface Mines

• **Implement Good Operating Practices** – Train operators to take personal responsibility for minimizing dust.

• **Employ Good Engineering Practice** – Enclose and contain dust. Transfer points should be enclosed on three sides, fitted with a dust curtain and covered.

• **Use Spray Systems to Control Visible Dust** – High pressure spray systems are the work horse of dust control in most plants. Fog, surfactant, and foam systems can offer advantages in special applications.

• **Install a Dust Collector** – Baghouses are the most efficient method for the collection of -10 micron particulate (PM10). They may be the only alternative for reactive (cement) or hazardous (silica) dusts.
Believe It or Not!

Good dust control and good process control are not mutually exclusive. Good operating practice can minimize dust and maximize production. Examples:

• **Choke Feed Crushers** – pushing more stone, coal or ore through a crusher means moving less air and results in less dust. This is especially true of impact crushers and hammermills.

• **Avoid Interruptions in Process Flow** – production equipment can produce more than ten times the airborne dust when it is empty and “windmilling”.
Good Engineering Practice

• Enclose Dust Sources
  Examples:
  ➢ Enclose transfer points on three sides and cover
  ➢ Install dust curtains at discharges to conveyors
  ➢ Install dust skirts that provide a tight seal to conveyor. Use dual skirts if necessary.

• Landscape
  Examples:
  ➢ Put the plant “in-pit”. Out of sight is out of mind
  ➢ Use berms, fencing or vegetation to shelter plant from the wind.
  ➢ Vegetate barren areas to protect from wind erosion.
Spillage indicates poor enclosure and seals. Workers that clean this material out can be exposed to high levels of respirable dust.
Unenclosed transfer points allow dust and spillage to escape.
Load points should be enclosed on three sides, covered and equipped with a dust curtain.
Belt Skirting

Simple Edge Sealing System
A single skirtboard is used to contain material. This is the most common but least effective seal.

Multi-Layer Sealing System
A rigid skirtboard and flexible seal provide much better containment. Wear plates protect the skirting.
Impact beds support the conveyor at the load point and improve the seal to the chute. This helps to reduce dust and spillage.
Wet Suppression Systems

Advantages:
• Low capital costs
• Low maintenance costs
• Prevent dust by reducing the potential of the substrate to emit particles

Disadvantages
• Can cause wet handling problems like belt carryback or screen blinding
• May increase crusher wear
• Cannot be used on water soluble or reactive materials
• Hard to use in freezing weather
Spray Treatment Points

• **Hoppers** – Hoppers require a brief but high volume burst of spray when trucks, loaders, or railcars dump.

• **Crushers** – Spray treatment at crushers is critical. Spray treatment controls emissions and relies on the mixing action of the machine to distribute moisture uniformly.

• **Screen Discharge Chutes** – Avoid spraying on top of screen decks. Treat the sized material as it comes off the screen.

• **Stacking Conveyors** – Stackers handling finer sizes require spray treatment of the material as it falls onto piles.

• **Transfer Points** – Treat at transfer points as necessary. Upstream spray treatment should generally control emission.
Spray System Layout for Aggregate Processing
Water Spray System Design

• **Use High Pressure** – the higher the pressure that better the atomization and the lower the water consumption.

• **Size Pump to Add a Maximum of 0.5% Water** - This corresponds to 20 gpm per 1000 tph of process flow (@ 200 psi).

• **Adjust Water Flow in Response to Dust Levels.** Add just enough water to control the dust but not so much as to adversely affect production.

• **Use Electronic Control** - Automation helps to reduce operator error and water consumption.

• **Use Heavy-Duty Construction** – Cheap pumps and parts will not hold up. If spray system breaks down, you may violate your permit conditions if plant continues to operate.
How not to design a spray system
Low spray pressure and plugged nozzles reduce control efficiency. Spraying water onto empty belts causes “carryback”.

![Image of spraying water onto empty belts]
Five Good Reasons not to Build Your Own Spray System

• If you do it right, you won't save any money. A well-designed spray system that uses quality components will cost just as much as a good commercial system.

• If you do it wrong, it'll cost you production. If you build a cheap spray system you'll save some money but you'll pay for it in lost production and higher maintenance.

• Whose going to build it? Most plants these days barely have enough manpower to keep production equipment operating much less to design, build and install a spray system.

• Whose going to fix it? When your DIY system breaks down - and it will - there's no manual, there's no spare parts list and there's no one who knows how to fix it.

• It is rocket science. Dumping enough water on the stone to kill the dust is easy. Adding just enough water to kill the dust without sacrificing production requires expertise.
High pressure spray systems can control dust and minimize water consumption. At 200 psi, a spray system can be expected to add from 0.2% to 0.5% by weight to the process. Spray systems operating at less than 100 psi will require double that amount of water for the same level of dust control because they lack the atomizing and penetrating power required.
Typical pump module uses a 200 psi pump and motor integrated with an electronic control system.

Electronic control enables the operator to control the system remotely. Systems can be automated and equipped with air and glycol purge systems to protect nozzles when they are shut down in cold weather.
Spray Nozzle Installation

Spray nozzles should be:

• Targeted at the Dust Source – nozzles that spray onto belts or steelwork cause wet handling problems.

• Able to be seen – operators need to be able to see nozzles to verify they are working properly. Nozzles stuck into chutes or behind curtains won’t get inspected.

• Easy to reach – nozzles that are hard to get to won’t get cleaned or replaced. Poor nozzle maintenance results in poor dust control.
Spray Bar Construction

Typical spray manifolds are made from galvanized pipe and brass hose fittings. The spray bar is secured to the superstructure with unistrut.
Nozzles Must be Visible

Keep nozzles outside of chutes so that operators can see them. If they can’t be seen and easily accessed, they won’t be inspected and maintained.
Nozzle Pluggage

Most nozzle pluggage occurs due to deposition on spray bars resulting from poor source enclosure.

Install dust curtains to prevent deposition due to “blowback” of mist and wet fines
Spray System Operation Guidelines

• **Turn spray lines on only when you see dust.** Do not turn on the spray system if there are no emissions.

• **Use water sparingly.** Use the minimum number of nozzles to control dust.

• **Turn spray lines off when process flow is interrupted.** Nozzles that continue to spray on empty belts cause wet handling problems.

• **Add water as early in the process as possible.** Using water in a primary circuit will help to reduce water addition rates in a secondary or tertiary plant.

• **Operate at 200 psi.** High spray pressure makes more efficient use of water and keeps water consumption down.
Cold Weather Guidelines

- **Install a thermometer** to alert the operator to freezing temperatures.

- **Minimize the number of spray lines in service.** Use only essential spray nozzles.

- **Make sure that nozzles are properly targeted.** Nozzles should not spray on steelwork or conveyor belting.

- **Drain hose lines immediately** after they are taken out of service. Do not allow water to sit in lines and spray manifolds.

- **Keep all drain valves open after the system has been drained** to prevent any residual water from freezing and cracking the valve.

- **Make sure that spray lines run straight and true and that drain valves are located at all low points.** Bends, loops, and kinks in hose lines will make lines more difficult to drain in cold weather.
Winter Operation

Water spray systems are not designed for continuous use in freezing temperatures unless:

The pump is in a heated enclosure and:

1. Output spray lines and nozzles are wrapped with heat tape and insulation

   OR

2. The pump is supplied with an aqueous solution of a non-toxic glycol or corrosion inhibited, brine-based anti-freeze.

DON’T LEAVE THE PUMP OUT IN THE COLD!
Baghouses

When high collection efficiency on small particle sizes is required, the most widely used method is a baghouse.
Dry Collection

Advantages:
• High efficiency for finer particle sizes
• Able to operate in any weather
• Can collect water soluble or reactive dusts
• BACT (Best Available Control Technology)

Disadvantages
• High capital cost
• High operating and maintenance costs
• Dust disposal can create secondary emissions
Dry Collection Systems

There are three major types of fabric filters or baghouses:

• **Mechanical Shaker** – Use vibration to shake off the dust cake.

• **Reverse Air** - Are compartmentalized to allow continuous operation. Filtration is interrupted in the compartment to be cleaned. Clean air is injected in a reverse direction, causing the dust cake to fall into the hopper.

• **Pulse Jet** - Can be operated continuously and cleaned without interruption of flow because the burst of compressed air is very small compared with the total volume of dusty air through the collector.
Typical Baghouse Installation
Selecting a Dust Collector

• **Dust concentration and particle size** - For minerals processing, dust concentration can range from 0.2 to 12 grams per standard cubic meter, and the particle size can vary from 0.5 to 100 µm.

• **Degree of dust collection required** - depends on potential as health hazard or nuisance, the plant location, the allowable emission rate, the nature of the dust, and its salvage value.

• **Characteristics of airstream** - High temperature or condensation of water vapor can damage bags or cause corrosion.

• **Characteristics of dust** – Some dusts can be abrasive. Hygroscopic material can blind bag collectors. Sticky material can adhere to collector elements and plug passages.

• **Methods of disposal** – depends upon plant process, volume, and type of collector used.
Common Problems

• Undersized fans that do not have the capacity to maintain the minimum velocity required to prevent dust from settling in ductwork.

• Sharp bends in ductwork that cause turbulence that aggravates wear or eddies where dust can settle out.

• Too many pick-up points can make it impossible to balance air flows.
RACM for Longwall Mining Dust Control

1. Controlling Dust from Belt Entry

• Belt maintenance – Missing rollers, slippage, poor alignment and wear can combine to increase dust.

• Wet the coal - If the coal is wet at the face, less dust is created. Water rates range from 1 – 4 gpm at 50 psi.

• Scrape and wash conveyor – a scraper and a little water to dampen the belt goes a long way to decreasing dust.

• Rotary brush to clean conveyor – locate the brush near the dump point so that material sticking to the belt is still wet.

• Wet dry belts – wetting the non-conveying side of the belt and wiping with a piece of carpet or mop head prevents dust stuck in cracks from becoming airborne.
2. Controlling Dust from the Headgate Entry and Stageloader/Crusher

- **Enclose the stageloader/crusher** — use steel plate, belting, brattice or foam to seal the stageloader. Curtain inlet and outlet.

- **Spray the coal** — but avoid high pressure sprays that may force dust out of the enclosure.

- **Use scrubber in the stage loader crusher** — water powered venturi scrubbers can reduce dust by more than 50% but are high maintenance.

- **Install a gob curtain** — to improve air flow along the face.

- **Position operators outby as the headgate drum cuts into the headgate entry** — although cutout time is short there is a lot of dust, position operator behind face conveyor drive motors near shields 1 and 2.

- **Install wing curtain between panel side rib and stageloader** — the wing curtain directs airflow around the drum. Locate curtain 6 ft. from the corner of the face.
A gob curtain increases airflow along the face and decreases airflow through the gob pile.
Ventilation patterns around shearer without (left) and with (right) a cutout curtain.
3. Controlling Shearer Dust

- **Face ventilation** – need a minimum of 400-450 fpm. Higher flows are more efficient but have to keep coal and roads wetter so they don’t dry out as fast.

- **Drum-mounted water sprays** – very effective because they spray at the cutting face but if pressures too high (> 100 psi) they can actually force dust away from the face and disperse it.

- **Cutting drum bit maintenance** – dull bits produce more dust.

- **Directional water spray system (Shearer- Clearer)** – sprays should be oriented downwind to augment primary air flow and hold dust against the face.

- **Keep headgate splitter arm parallel to top of shearer** – positioning the splitter arm so that it is level with the shearer body and parallel to the floor helps to prevent dust from migrating over or under the splitter arm and into the walkway.
Controlling Shearer Dust (cont’d)

- **Shearer deflector plates** – used to protect operators from flying debris also help to hold dust against the face. Should be raised as high as possible.

- **Crescent sprays** – located on the top and end of each ranging arm and aimed inward toward the cutting drum. Sprays on the headgate ranging arm, however, are oriented into the face airflow and may create turbulence that increase dust levels.

- **Lump breaker spray manifold** – a spray nozzle here can provide better, more uniform wetting of coal but keep pressures below 80 psi.

- **Tailgate side sprays** – sprays on tailgate side splitter arm can help to confine dust against the face. Keep pressures below 80 psi to reduce turbulence.
Shearer-clearer directional spray system.
Venturi sprays mounted on headgate splitter arm.

Headgate splitter arm with flat-fan sprays mounted on gob side of belting.
Directional sprays mounted on face side of shearer body
Position of splitter arm may allow dust to migrate into walkway.
Raised deflector plate can enhance the effectiveness of the directional spray system.
Crescent sprays located on shearer ranging arm.
Spray manifold mounted on tailgate end of shearer body.
4. Controlling Shield Dust

- **Canopy mounted spray system** – have been available for years and activate sprays onto the roof material shortly before and during advance of the shield. Hard to maintain and not very effective.

- **Shield spray on the underside of the canopy** – underside sprays activate automatically by the position of the shearer to create moving water curtain. Results have been mixed and proper on/off sequencing is critical.

- **Air dilution** – If shields are advanced upstream of the shearer, do so as far upstream of the shearer as possible. This may allow dust generated by shield movement to mix with clean air and dilute before it reaches the shearer.

- **Unidirectional cutting sequence** – allows operators to modify the cut sequence so that shields are only advance downwind of the shearer.
Shield sprays on the underside of the canopy.
RACM for Continuous Miner Dust Control

1. Water spray systems
   a. Air atomizing
   b. Hollow cone
   c. Flat spray
   d. Full cone
Relative spray effectiveness of four spray nozzles used in mining. Air atomizing nozzles are most efficient, full cone least efficient. The smaller the droplets, the better the dust control.
Continuous Miner Spray Systems

Spray Systems are used to:

- **Minimize Dust Rollback** – Top and side nozzles should be arranged for “low” reach and no overspray. Keep spray pressure under 100 psi
- **Contain Dust at the Face** – locate fan sprays 1 ft. back from cutter head on both sides of the miner to act as blocking sprays.
- **Improve Ventilation** – High pressure (> 150 psi) fan sprays can be used to direct fresh intake air to the cutting face, sweep contaminated air across the face, and direct the airflow into the return airway.
Spray system for continuous miner
Spray location impact on dust rollback
Continuous Miner Spray System Best Practices

• **Use Clean Water** – nozzle pluggage reduces control efficiency.
• **Inspect Nozzles Before Each Cut** – clean or replace nozzles as necessary.
• **Change Cut Sequence** – cut throughs should be made from intake to returns *when practical* to prevent return air from blowing back over the operator.
• **Use Remote Control** – makes it possible for miner to stay outby the continuous miner.
RACM for Continuous Miner Dust Control

2. Flooded-bed Scrubbers

• Used because remote control allows continuous miners to make extended cuts but does not allow the miner to advance the ventilation curtain to the face where dust can accumulate.
• Flooded bed scrubber inlets are mounted close to the cutter head and pass through a filter panel that is wetted with water sprays.
• Control efficiencies of 90% are obtainable.
• Scrubbers are high maintenance and require frequent cleaning.
SCRUBBER MAINTENANCE

(1) Twice each shift: Clean filter with water.

(2) Once each shift: Replace filter, back-flush dirty filter with water and allow to dry. When dry, shake remaining dirt from filter before reusing.

(3) Daily: Wash inlets and ductwork with water.

(4) Weekly: Wash venturi, sump, and demister module.
RACM for Continuous Miner Dust Control

3. Bit Type and Wear

Proper bit design can lower dust generation

- Large carbide tip
- Smooth carbide to steel transition
- Low wear rate,
- Low dust levels
If roof rock must be cut, cut the coal beneath the rock first and then back the miner up to cut the rock. This cuts the rock in a less confined space which lowers exposure to silica dusts.
Schematic of blowing face ventilation where intake air is delivered to the face by blowing it from behind line brattice
Blowing Face Ventilation Best Practices

- Position operator in the mouth of the blowing line curtain with intake air sweeping from behind.
- When operator has to move from the clean air position, allow dusty air to settle and stop the scrubber before moving.
- Brattice discharge velocities should exceed 800 fpm
- Scrubber should exhaust directly into return air
- Air quantity provided by the line curtain should be limited to 1000 cfm over the scrubber capacity. Air quantities over 1000 cfm can overpower the scrubber.
6. Exhausting Face Ventilation

Intake air is delivered to the face and dusty air is drawn behind the return curtain or through the exhaust tubing of the scrubber to the return entries. Exhausting face ventilation gives operator more options to avoid dusty air and shuttle car operators are always positioned in fresh air.
Exhausting Face Ventilation Best Practices

- Air quantity reaching the inby end of the line curtain should be equal to or slightly greater than scrubber capacity to prevent air recirculation.
- Mean entry air velocity must be at least 60 ft/min (MSHA reg).
- End of exhaust curtain or tubing must be kept within 10 ft. of the face when not using a scrubber.
- Operator must not proceed inby the end of the line curtain to avoid exposure to return air.
- Scrubber exhaust must be on the same side of the entry as the line curtain to allow the scrubber to exhaust directly into return air.
RACM for Roof Bolting Dust Control

1. MSHA Approved Dry Dust Collector

- Collection Side:
  - Drill Bit
  - Drill Steel
  - Drill Base
  - Collector Hose
  - Pre-Cleaner
  - Canister Filter

- Discharge Side:
  - Vacuum Pump
  - Muffler
Dust collector box with collector bag installed
Roof Bolting Dust Control Best Practices

- Maintain dust collector system
- Clean the dust box (wear respirator)
- Use dust collector bags to make cleaning easier
- Clean discharge side of collector
- Install a sock on pre-cleaners – reduce re-entrainment when dust falls to floor
- Use “Dust hog” bits – more effective than shank bits
- Do not work downstream of continuous miner
RACM for Roof Bolting Dust Control

2. Wet Drilling

Wet drilling can effectively control dust

• Requires about 2 gpm

• Water flow onto mine floor can create wet floor problems and make work environment uncomfortable.

• Mist drilling (0.5) gpm not as effective as wet drill or dry collector
RACM FOR INTAKE AIRWAYS

Brief but sporadic dust emissions can contaminate intake air due to delivery of supplies/personnel, equipment parked in intakes, rock dusting, scoop and construction activity

Best management practices include:

• Good Housekeeping

• Supply delivery, scoop activity, construction and rock dusting should be dedicated to non-production shifts

• Keep haulage roads damp or use dust suppressing agent

• Park equipment in crosscuts to keep main airways clear
RACM FOR FEEDER-BREAKERS AND SHUTTLE CARS

Best management practices include:

- MSHA recommends hollow- or full-cone sprays at the feeder-breaker transfer point to wet and knock down dust.
- When shuttle cars unload, use automated sprays at the mouth of the feeder-breaker to wet coal before it enters the crusher.
- Throat sprays on the continuous miner will lessen dust when transferred to and from shuttle cars.
- Shuttle cars should not be in a waiting position beneath check curtains.
- Shuttle car operators should not be located in the direct discharge of the dust collector (scrubber) on the continuous miner.
- When blowing ventilation is used, configure shuttle car runs to minimize the amount of time spent in return air.
Preventive Maintenance

When you find dust controls that work, keep them working!

• Institute a program of routine preventive maintenance for all dust control equipment.

• Poor maintenance of dust control equipment is the main reason for fines and citations. Pollution control equipment must be maintained just like production machinery.