UMassAmherst | Environmental Health & Safety

Mineral Dusts SOP

What are mineral dusts?

Mineral dusts, such as those containing crystalline silica, coal, and cement dusts, can be found in many work environments. Dusts usually originate from larger pieces of the same material, through one or several mechanical breakdown processes such as grinding, cutting, drilling, crushing, or strong friction between certain materials, such as rocks. It can also be generated from handling powders that contain mineral dust, such as cement mix. The composition of mineral dusts is not necessarily the same as that of the parent rocks because different minerals may break down or be removed at various rates. Common examples of mineral dusts include, but are not limited to:

- Crystalline silica
- Amorphous silica, including natural diatomaceous earth
- Silicates
- Graphite
- Coal dust
- Inert or nuisance dust (dusts without specific exposure standards)

Crystalline silica is a common mineral found in the earth's crust and a basic component of soil, sand, granite, and many other minerals. It is also used to make products such as glass, pottery, ceramics, bricks, and artificial stone. Quartz is the most common form of crystalline silica. Cristobalite and tridymite are two other forms of crystalline silica. All three forms may become respirable size particles when workers chip, cut, drill, or grind objects that contain crystalline silica. Free silica can occur in these three crystalline forms. Quartz occurs in rocks such as granite, sandstone, flint, slate, and many others, as well as in some types of coal and metallic ores. Note that silica gel typically used in labs for chromatography does NOT contain crystalline silica.


Quartz


Talc


Sandstone


Mica


Graphite


Cement

Source: https://flexiblelearning.auckland.ac.nz/rocks_minerals/

Source: https://mineralseducationcoalition.org/minerals-database/

What are the hazards?

Health hazards associated with exposure to elevated levels of mineral dusts depends on the type of dust, which will determine its toxicological properties, and hence health effects. Health effects from exposure to mineral dusts may become obvious only after long-term exposure. Health effects may appear after the exposure has ceased. However, many dusts have more immediate effects that result from shorter exposures to higher concentrations. Health effects may result from exposure to different types of dust and include pneumoconiosis, cancer, systemic poisoning, irritation and inflammatory lung injuries, allergic responses (including asthma and extrinsic allergic alveolitis), infection, and effects on the skin. The same agent can cause a variety of adverse health effects.

Pneumoconiosis results from the accumulation of dust in the lungs and an inflammatory reaction to the presence of this dust. Pneumoconiosis may be produced by inhalation of excessive amounts of the following dusts: coal dust, beryllium (berylliosis), kaolin (kaolinosis), barium (baritosis), tin (stannosis), iron oxide (siderosis), talc, graphite, and mica. With the exception of berylliosis, these other pneumoconioses are relatively benign.

Silicosis is a fibrotic lung disease that is caused by overexposure to dusts composed of or containing free crystalline silica. It is irreversible, progressive, incurable, at later stages disabling and eventually fatal. The silicosis risk depends on the amount of free crystalline silica inhaled and actually deposited in the alveolar region. When there is breakdown of sand, rocks or ores containing free crystalline silica, severe hazard may exist from increasing with the proportion of respirable particles and the free silica content of the dust. Crystalline silica has been classified as a human lung carcinogen. The respirable silica dust enters the lungs and causes the formation of scar tissue, thus reducing the ability of lungs to take in oxygen. Since silicosis affects lung function, affected people may be more susceptible to lung infections, such as tuberculosis. In addition, smoking causes lung damage and adds to the damage caused by breathing silica dust. Workers who inhale these very small crystalline silica particles are at increased risk of developing serious silica-related diseases, including, but not limited to:

- Silicosis, an incurable lung disease that can lead to disability and death
- Lung cancer

- Chronic obstructive pulmonary disease (COPD)
- Kidney disease

Dusts may have health effects on other organs as well. Several studies have found effects on the cardiovascular diseases related to dust exposure (Seaton et al., 1995).

Occupational Exposure Limits

The OSHA Permissible Exposure Limits (PELs, 8-hour Time Weighted Averages) for mineral dusts listed below are from Table Z-3 of 29 CFR 1910.1000. ACGIH Threshold Limit Values (TLVs, 8-hour Time Weighted Averages) for mineral dusts listed below are from ACGIH® 2019 Threshold Limit Values.

	OSHA PELs		**ACGIH TLVs**
Substances	mg/m^3	mppcf*	mg/m^3
Cystalline silica	0.05 (with an action level of 25 $\mu g/m^3$)	/	0.025 (as the respirable fraction for α-quartz and cristobalite)
Talc	/	20	2 (not containing asbestos)
Mica	/	20	3 (as the respirable fraction)
Soapstone	/	20	2
Portland cement	/	50	1 (not containing asbestos)
Graphite (natural)	/	15	2 (respirable, natural, all forms except fibers)
Coal dust	/	/	0.9 (as the respirable fraction) bituminous or lignite; 0.4 (as the respirable fraction) anthracite
Inert or Nuisance Dust	/	15 (as the respirable fraction) and 50 (total)	/

*mppcf: Millions of particles per cubic foot of air.

For more information, please refer to OSHA PELs Table Z-1 (https://www.osha.gov/dsg/annotated-pels/tablez-1.html), Table Z-3 (https://www.osha.gov/dsg/annotated-pels/tablez-3.html), NIOSH Pocket Guide to Chemical Hazards (https://www.cdc.gov/niosh/npg/default.html) and ACGIH® 2019 Threshold Limit Values.

What Activities Could Pose a Risk?

Mineral dusts can be generated in labs when using equipment and conducting procedures including, but not limited to:

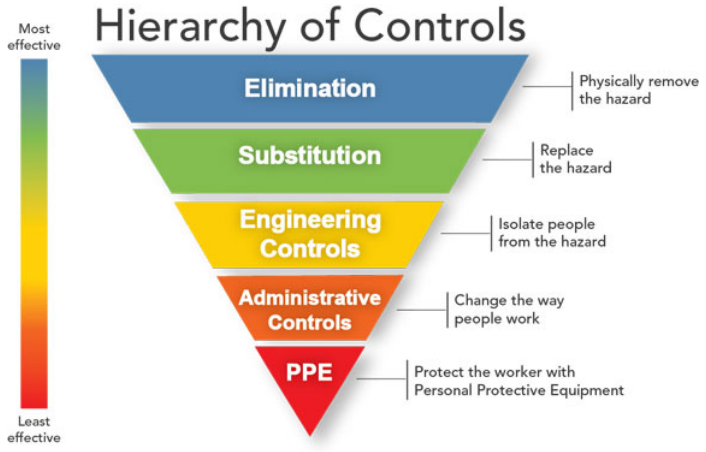
- Jaw crusher
- Impact crusher
- Roll crusher
- Cone crusher
- Knife mill
- Rotor mill
- Disk mill
- Mortar grinder
- Ball mill
- Cutting mill
- Beater mill
- Mixer mill
- Shatterbox
- Sieve shaker
- Sieving crushed or powered samples/materials
- Transferring crushed or powered samples/materials from the catchment pans on these instruments into the storage containers.
- Cleaning equipment

The most common exposure route of mineral dusts is inhalation, however, ingestion could also cause exposure to mineral dusts. Ingestion can occur when solids are cleared from airways if airborne exposure occurs or from contaminated hand to mouth contact.

How Can Exposures Be Minimized?

When working with mineral dusts, or any other hazardous material, always conduct a thorough risk assessment and employ the hierarchy of controls to minimize risk. Some specific applications of the hierarchy of controls to the hazards of mineral dusts are listed below.

Always apply the controls in the order of most effective to least effective (see graphic), and apply as many controls as possible to reduce the risk to the lowest achievable level.



- Do not use silica sand or other substances containing more than 1% crystalline silica in a manner that generates airborne dust.
- Replace crystalline silica materials with safer substitutes, whenever possible.

Engineering Controls

- Use engineering controls where available, such as local exhaust ventilation (such as a fume hood, cyclone dust collectors and HEPA filters, or other containment devices).
- Routinely maintain dust control systems, such as air filters or cyclones, to keep them in good condition. Ensure that Physical Plant is aware of any building air filters that might need to be changed.

Administrative Controls

- Recognize when silica dust and other mineral dusts may be generated and plan ahead to control the dust at the source.
- Practice good personal hygiene to avoid unnecessary exposure to other contaminants.
- If clothing is contaminated with dust, change clothes before leaving the work area to prevent cross contamination of cars, homes, and other areas.
- Keep containers closed while mixing or performing other activities which could generate dust. Allow dust to settle before opening containers or before attempting to clean any spills.
- Minimize handling of containers of dust to prevent spills.
- Use containment methods, such wet methods when possible (e.g., wet sieving), to control the hazard and protect adjacent personnel from exposure.
- Clean areas where mineral dusts are generated regularly to prevent build up and inadvertent exposure to materials. Use wet methods, such as a sponge with soap and water, or vacuuming. Only use vacuums equipped with HEPA filtration. Use bench paper, or other disposable coverings or enclosures, when possible to facilitate clean up.
- Ensure laboratory personnel are thoroughly trained on the hazards of mineral dusts, routes of exposure, and hazard mitigation techniques.

Personal Protective Equipment

- Always wear appropriate eye protection.
- Wear protective outer clothing for working with dusts to prevent contamination of clothing. Use disposable items or launder outer garments regularly.
- In cases where engineering controls do not provide sufficient protection for inhalation exposure, please wear only NIOSH certified respirators. If there is concern that available engineering controls are not sufficient to adequately control dusts, then please contact EH&S. EH&S will work with you to determine the appropriate respirator based on a risk assessment for the dust generating processes. Respirator users must enroll in the

University's Respiratory Protection Program (https://ehs.umass.edu/respiratory-protection-program).

For an exposure requiring the use of eyewash:

- Have someone call 911 (report the building name, room number, and street address) or 413-545-3111 (or simply 5-3111 from a campus line) to report the incident and request medical help. Have someone obtain the SDS for the material (if there is one) and provide it to the first responders when they arrive, if possible.
- Help the affected individual to position their head over the eyewash and activate it.
    - Always ensure your own safety before helping others. Only help if it is safe for you to do so.
    - Wear gloves, safety glasses, and a lab coat.
- Instruct the affected individual to open their eyes and roll them around while the water is flowing. Help them to hold their eyes open if necessary and safe to do so.
- Flush the affected area for 15 minutes with water.
- Notify EH&S (413-545-2682) as soon as possible and complete the lab incident form (https://ehs.umass.edu/lab-incidents-and-lab-incident-report-form).

References and Additional Resources

1. Occupational Safety and Health Administration (OSHA) "Crystalline Silica Exposure" Health Hazard Information for General Industry Employees: https://www.osha.gov/Publications/osha3176.html
2. Occupational Safety and Health Administration (OSHA) Safety and Health Topics - Silica, Crystalline. https://www.osha.gov/dsg/topics/silicacrystalline/
3. The National Institute for Occupational Safety and Health (NIOSH) Workplace Safety and Health Topics – Silica. https://www.cdc.gov/niosh/topics/silica/default.html
4. World Health Organization. Hazard prevention and control in the work environment: Airborne dust (WHO, 1999). https://www.who.int/occupational_health/publications/airdust/en/
5. Occupational Safety and Health Administration (OSHA) Annotated TABLE Z-3 Mineral Dusts. https://www.osha.gov/dsg/annotated-pels/tablez-3.html
6. Occupational Safety and Health Administration (OSHA) Annotated TABLE Z-1. https://www.osha.gov/dsg/annotated-pels/tablez-1.html
7. ACGIH® 2019 Threshold Limit Values for Chemical Substances in the Work Environment. See http://www.acgih.org/.
8. National Institute for Occupational Safety and Health (NIOSH) (2016) NIOSH Pocket Guide to Chemical Hazards. Department of Health and Human Services. Centers for Disease Control and Prevention. National Institute for Occupational Safety and Health (NIOSH). Web site accessed on July 7, 2016. Available at http://www.cdc.gov/niosh/npg

9. Occupational Safety and Health Administration (OSHA) (2017) Air Contaminants. 29 CFR 1910.1000 [82 FR 2735, January 9, 2017]. Web site accessed on April 4, 2018. Available at http://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1000.
10. Thorpe A, Ritchie AS, Gibson MJ, Brown RC (1999). Measurements of the effectiveness of dust control on cut-off-saws used in the construction industry. Annals of Occupational Hygiene, 43(7):443-456.
11. International Agency for Research on Cancer (IARC): Silica Dust, Crystalline, in the form of Quartz or Cristobalite. https://monographs.iarc.fr/wp-content/uploads/2018/06/mono100C-14.pdf
12. Seaton A, MacNee W, Donaldson K, Godden D (1995). Particulate air pollution and acute health effects. The Lancet 345:176-78.
13. National Institute for Occupational Safety and Health (NIOSH): Preventing Silicosis and Deaths in Construction Workers. https://www.cdc.gov/niosh/docs/96-112/default.html