Clothes Cleaning Process

CDC Workplace Safety and Health

NIOSH National Institute for Occupational Safety and Health

Instructional Materials

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Notice to U.S. Operations:

This Clothes Cleaning Process is not currently approved by the Mine Safety and Health Administration (MSHA). A petition for modification to use this system was submitted by Unimin Corporation for its Marston facility and approved by MSHA in June 2004. For U.S. companies seeking to implement this system, contact Andrew Cecala to receive information on filing a petition for modification.

This pamphlet and the enclosed video describe a safe, effective and economical method for removing dust from work clothes.

Background Information

Dusty work clothes can increase a worker's exposure to respirable dust. Respirable dust is usually considered to be particles having an aerodynamic diameter of 10 microns or less and able to enter and deposit in the gas-exchange region of the human lung. A former U.S. Bureau of Mines report documented a 10-fold increase in worker dust exposure on a number of separate occasions from dusty work clothes.* It was found that once clothes become contaminated, they are a continual dust source until cleaned.

The only MSHA-approved method to clean work clothes requires a HEPA-filter vacuuming system which is very time consuming and difficult to perform effectively. Therefore, most workers use a single air hose (not MSHA-approved) which can elevate dust levels for the worker, co-workers, and the work environment.

A substantial amount of engineering technology has been developed that, when applied, can significantly lower respirable dust exposures of workers at mineral processing plants. But even with these improvements, some workers continue to exceed their permissible exposure limit. Elevated exposures increase the potential for developing debilitating or fatal lung diseases. The clothes cleaning method described within is an example of a continuing effort to reduce the potential for developing these lung diseases.

Information about engineering research by the former U.S. Bureau of Mines and NIOSH can be found online at www.cdc.gov/niosh. This website can also be used for obtaining NIOSH information about health hazards associated with crystalline silica.

**Cecala, A.B. & E. D. Thimons. Impact of Background Sources on Dust Exposure of Bag Machine Operator. BuMines IC 9089, 1986, 10 pp.*

Crystalline Silica and Health Risks

Crystalline silica is the combination of silicon and oxygen, chemically uncombined with any other element, where the atoms are arranged in a repeating 3D crystalline structure. The mineral quartz is the most common form of crystalline silica. This unique mineral has shaped human history since the beginning of civilization and has been used in glass; ceramics (china, porcelain, cookware, floor and wall coverings); fiberglass; water filtration; and to make steel. There are no known substitutes for this mineral.

The International Agency for Research on Cancer (IARC) currently ranks crystalline silica as a Group 1 substance, meaning that "if inhaled in the form of quartz or cristobalite from occupational sources is carcinogenic to humans."

Silicosis

Silicosis is a lung disease resulting from occupational exposure to silica dust. Silicosis causes slowly progressive fibrosis of the lungs, impairment of lung function, and tuberculosis. Crystalline silica of respirable size is primarily quartz dust occurring in industrial and occupational settings in the form of fine, breathable particles.

Intense exposure to silica dust can lead to rapid onset of silicosis. In Gauley Bridge, WV, in the 1930s, 764 workers died within months of exposure while digging the Hawk's Nest tunnel. This incident is widely regarded as the worst silica-related industrial disaster, and it brought silicosis to the nation's attention.

Silicosis can progress even after a person is no longer exposed to the dust, causing severe shortness of breath years later. The more years of exposure to dust, the greater the risk of the disease. Because there is no effective treatment for silicosis, prevention through exposure control is essential. Managing the dust and preventing the inhalation of particles are critical to reducing the risk of silicosis.

Project History

The Unimin Corporation plant in Marston, NC, grinds silica sand to a fine size. Tools and other equipment utilized to maintain this milling operation often become coated with finely ground silica dust. The plant's solution to clean this equipment was to construct a booth where compressed air could safely be used. The booth was constructed to accommodate down-draft ventilation, and the exhaust (containing the dust) was routed directly to the baghouse dust collector. The equipment cleaning system worked so well that the plant safety and health team suggested that the booth be modified so employees could clean their work clothes along with their tools. The intended result of this clothes cleaning process was to further reduce the potential dust exposure to employees in an already very clean facility.

"The Clothes Cleaning Process has been a cooperative research effort with NIOSH that Unimin Corporation has been pleased to be involved with..."

--Andy O'Brien, CSP
UNIMIN Health & Safety

In devising this clothes cleaning method, NIOSH researchers evaluated the effectiveness and time required to perform the existing methods: HEPA-filter vacuuming and a single-nozzle air hose (a method not approved by MSHA). As an alternative, several configurations of an air nozzle manifold were tested both in the laboratory and on-site using crushed limestone dust and coveralls made of cotton and a cotton-polyester blend. All subjects entered the booth wearing a fit-tested 1/2-face respirator equipped with N100 filters along with eye and ear protection. Respirable dust levels inside the respirators were below the Permissible Exposure Limits and the NIOSH-recommended exposure limits.

Results indicate that the manifold cleaned the clothes 10 times faster and removed approximately 50% more dust than the commonly used single air hose or vacuuming methods. Average cleaning time (inside the booth) was less than 20 seconds.

The Cleaning Process

Booth Dimensions‡

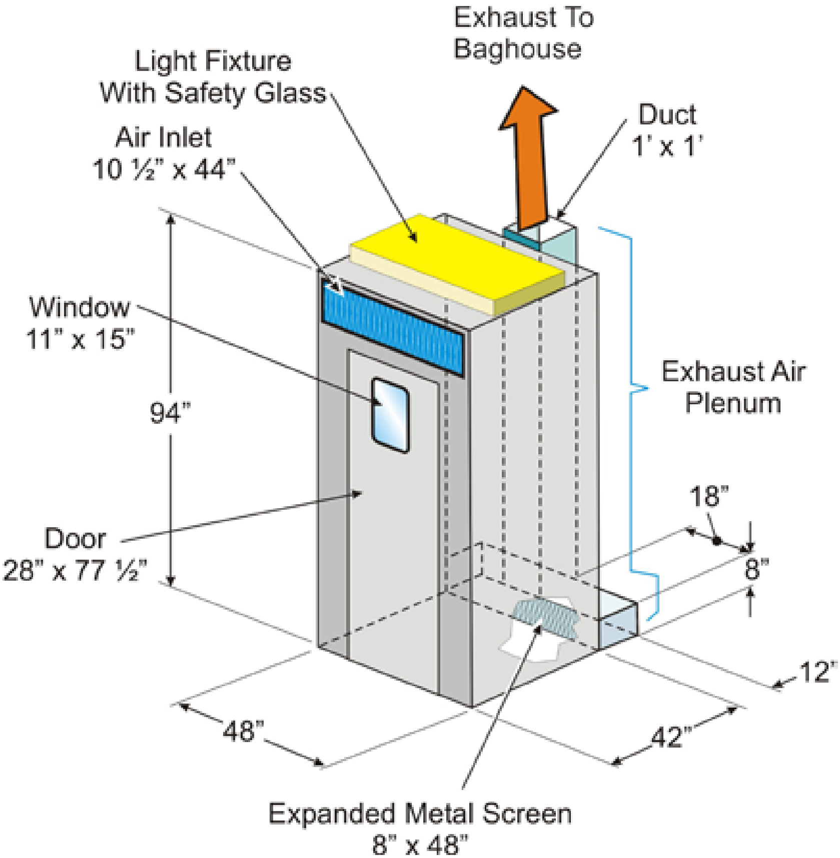

figure 1. Layout and design of booth used in this study.

‡*The excess capacity of the baghouse in the Marston plant determined the size of the booth used. For operations with different capacities, a smaller booth may be used thus lowering the cost.*

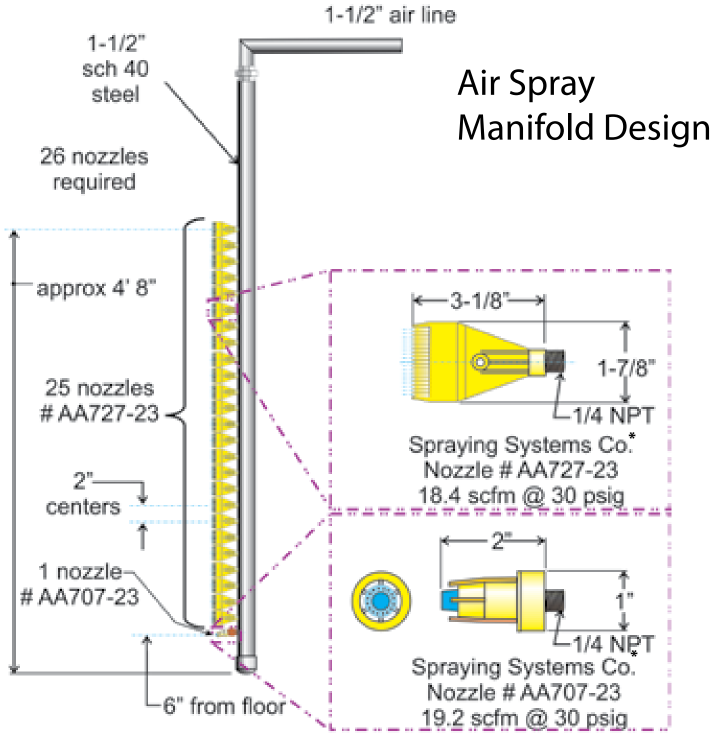

figure 2. Design of the air manifold system.

The air spray manifold consists of a piece of schedule 40 steel pipe, capped at the base. The cleaning process starts when the worker presses the electrical start button which actuates a time-controlled pneumatic valve, allowing air to flow to the manifold. The time-controlled valve is set for 18 seconds, which is ample time for the worker to rotate in front of the manifold. The valve has a safety interlock option, which automatically shuts off the air supply to the manifold if the exhaust ventilation system fails to keep the booth under sufficient negative pressure. Twenty-six air nozzles are mounted along the manifold, spaced on 2-inch centers. The manifold was drilled and tapped to ¼" NPT to accept these air nozzles. The bottom nozzle is a circular design located 6 inches from the floor.

**Vendor information provided does not imply endorsement or sponsorship by NIOSH or Unimin; it is furnished to provide cost estimates and comparison data.*

Each of the top 25 nozzles (flat fan design - No. AA727-23), are 1⅞-inches in width, which maximizes the effective cleaning width per nozzle. The bottom air nozzle (circular design - No. AA707-23), is mounted with a ball-type fitting and directed downward. During laboratory testing, this circular design was more effective when cleaning at greater distances and thus would be better suited for cleaning the worker's boots.

It is recommended that a side barrier be installed to protect the air spray nozzles, since the top 25 nozzles extend 3⅛ inches from the supply pipe and could easily be broken off if struck forcefully. During field testing, 1-inch wood sheeting was used along both sides of the nozzles, providing an effective barrier to minimize the potential for nozzle damage.

Compressed Air Volume Required

At 30 psi, 26 nozzles* expel 144 cubic feet of air from the reservoir tank in less than 20 seconds. The user must ensure that there is adequate pressure from the receiver tank (see table 1).

table 1. AIR RECEIVER CAPACITIES

TANK SIZE (inches)	TANK SIZE (gallons)	GAUGE PRESSURE ON TANK (PSI) 100	150	200
		CUBIC FEET TANK CAPACITY		
24 x 70	120	125	180	234
30 x 84	240	250	360	467

Exhaust Air Volume

The clothes cleaning booth at Unimin's Marston plant measured an exhaust air volume of 4,400 cfm with a negative static pressure of 0.16-inch w.g. in a booth with a volume of 110 cubic feet. It must be noted that while this facility had an excess exhaust air volume available in its baghouse collector, most operations will not have this luxury.

The volume delivered by the 26 nozzles must be added to the volume of the booth when calculating the required exhaust volume. Further,

** 25 Flat fan nozzles (Spraying Systems #AA727-23) and 1 Circular nozzle (Spraying Systems #AA707-23)*

Reservoir

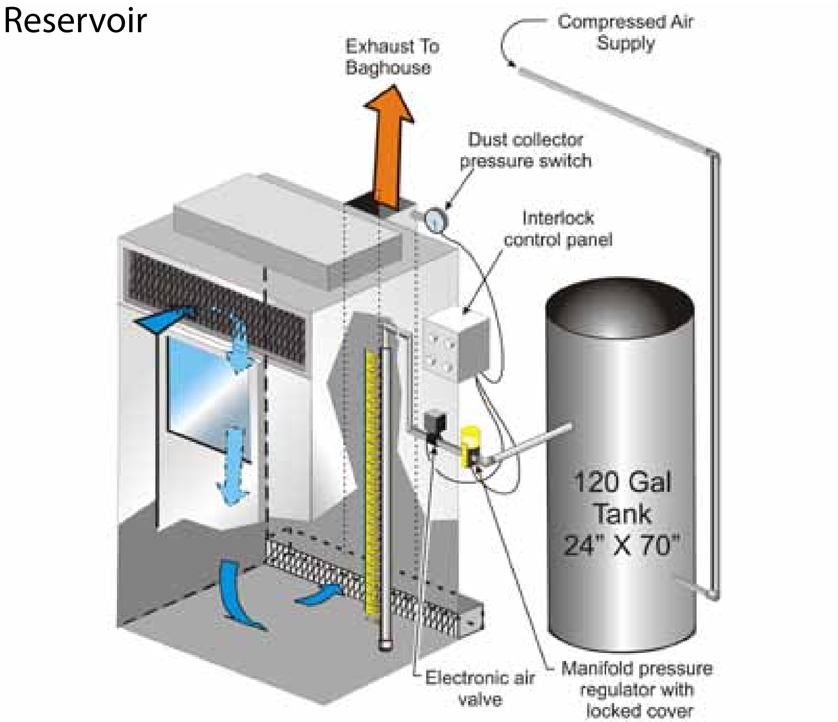

figure 3. The air flows from the plant's compressed air supply to the reservoir, and from there to the manifold.

the exhaust volume must be sufficient to maintain the booth's negative pressure during the operation of the air nozzle manifold, providing a fresh air exchange rate that prohibits leakage into the surrounding work environment.

table 2. CALCULATIONS

VOLUME OF AIR DELIVERED BY THE AIR NOZZLES
FLAT FAN NOZZLES: 25 nozzles X 18.4 cfm/nozzle = 460 cfm CIRCULAR NOZZLE: 1 nozzle X 19.2 cfm/nozzle = 19.2 cfm
TOTAL: (460 cfm + 19.2 cfm) X 1 min./60-sec X 18-second cleaning time = 144 cubic feet of air

Improved Booth Design

Over time, additional design changes, improvements and modifications were incorporated into the clothes cleaning system. The booth remains 48 by 42 inches which provides sufficient space for the worker to rotate in front of the air spray manifold while performing the cleaning process. The booth has been modified to provide a 2-foot opening in the roof where the intake air enters, then flows down through the enclosure before exiting through an air plenum on the bottom back of the booth. As the intake air flows through the booth, it entrains the dust removed from the worker's clothing during the cleaning process and forces it down towards the exhaust plenum and away from the worker's breathing zone. A 240-gallon air reservoir is recommended when multiple workers will need to clean their work clothing within a short period of time.

For effective dust removal, it is critical that the cleaning booth be ventilated under negative pressure at all times so as to not allow any dust liberated from the clothing to escape from the booth

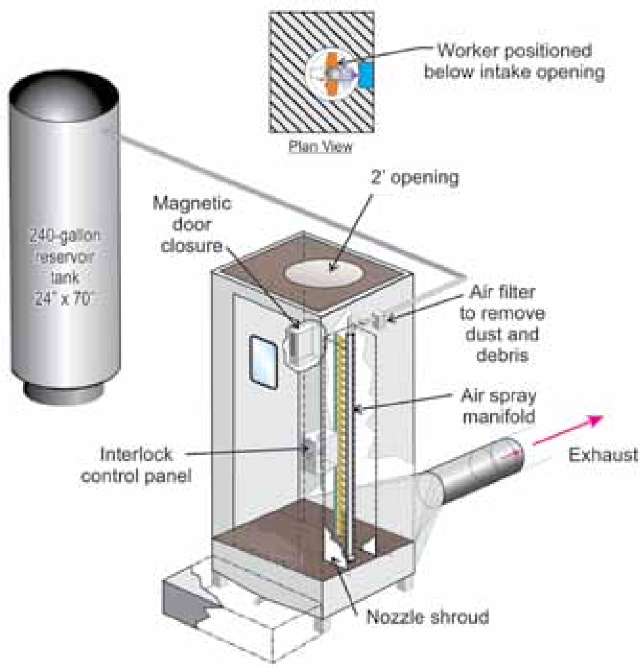

figure 4. This modification features a number of improvements to the clothes cleaning design to improve the airflow pattern through the booth to minimize potential exposure to the worker during the clothes cleaning process

and into the work environment. In the design stage of this technology, testing validated that an exhaust volume of 2,000 cfm was sufficient to maintain a negative pressure throughout the entire clothes cleaning cycle. A pressure switch should be incorporated into the system which will not allow the air spray manifold to activate unless an acceptable negative pressure is maintained within the cleaning booth.

For dust removal from the cleaning booth, in the original design, dust-laden air was exhausted from the booth and filtered by a local exhaust ventilation system. For operations which do not have excess collection capacity, removing the dust from the airstream can be performed using a HEPA filtering system which can be located in ductwork in close proximity to the cleaning booth. Another option for some operations is to duct the dust-laden air outside and then release it at a point where it does not pose a risk to outside personnel or to be recirculated back into the facility. This has been field tested and shown to be a viable option.

figure 5. Deflector slide (yellow) to prevent air from nozzles blowing into the face of shorter workers.

The air spray manifold was designed for a person 5 feet 10 inches in height. Taller workers will have to stoop and drop their shoulders to effectively clean their upper body. When a person is shorter, the top air nozzles can be covered with deflectors to prevent the air sprays from directly hitting a worker's face. A deflector has been designed for the system that allows a slide to cover a number of the upper nozzles to deflect the air for shorter workers. It should be noted that the air spray manifold can be modified to account for height characteristics of workers at individual operations.

Care & Maintenance

- Make sure all air nozzles on the spray manifold are working properly.

- Check all connections, fittings, valves, and air nozzles for leaks and proper operation.

- Determine that the cleaning booth is at an acceptable negative pressure. This can be achieved by measuring the air velocity or pressure in the exhaust duct or the static pressure in the booth.

- Determine that the air pressure does not exceed 30 psi being delivered to the air nozzles.

- Check receiver tank air pressure to determine that an acceptable air pressure is maintained.

- Ensure that air inlet and exhaust metal screen are completely open and free of debris.

Resources & References

Silica and Silicosis Sites on the Internet:

NIOSH: http://www.cdc.gov/niosh/topics/silica/default.html

MSHA: http://www.msha.gov/S&HINFO/SILICO/SILICO.HTM

OSHA: http://www.osha.gov/dsg/etools/silica/index.html

WHO: http://www.who.int/occupational_health/topics/silicosis/en/

National Industrial Sand Association: http://www.sand.org

Videos:

"Stop Silicosis" - MSHA #VC-826
"Silicosis: A Preventable Disease" - MSHA #VC-929

Works Cited:

"Crystalline Silica Primer," U.S. Bureau of Mines, 1992.

http://geology.usgs.gov/pdf/silica.html

MedicineNet.com

"Hawk's Nest Incident Summary," Ashley Lucas and Ariadne Paxton Cherniack, 1999.

"Impact of Background Sources on Dust Exposure of Bag Machine Operator," U.S. Bureau of Mines Information Circular #9089, 1986.

Clothes Cleaning Process Instructions

(as seen on the video)

1. **Don required personal protective equipment**
   - ☑ ½-face, fit-tested respirator w/ N100 filter
   - ☑ Hearing protection
   - ☑ Eye protection (full seal goggles required)
2. **Enter booth**
3. **Press "Start" button to activate air spray manifold**
4. **Rotate**
5. **When time-controlled pneumatic valve turns off the air spray manifold, the worker can exit the booth**

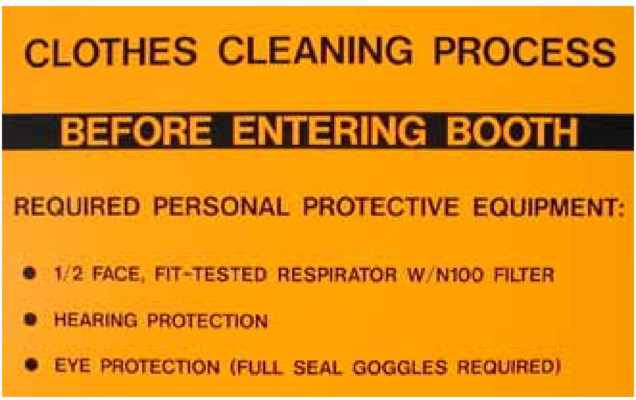

figure 6. Signage used on the door of the booth indicating the personal protective equipment required.

For more information on
the Clothes Cleaning Process contact:

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