Crystalline Silica Exposure and Control

Brandon Mann

Eastern Kentucky University

Abstract

Crystalline Silica Dust is a potential health hazard to employees, which is generated when materials containing silica are manipulated in such a way that the silica particles are broken into small airborne particles that enter the exposed employee's pulmonary system through respiration. The primary health hazard of silica dust exposure is silicosis, which is a pulmonary disease where fibrous nodules develop in the lungs and restrict the flow of air into the body. Other health effects include lung cancer, renal disease, pulmonary tuberculosis, lupus, rheumatoid arthritis, as well as others. OSHA began enforcing its new silica standard for general industry employees in June, 2018. The purpose of this paper is to examine the research behind the health effects of silica exposure, the requirements under the new silica regulation for general industry, and the recommendations for actions to be taken by Kansas county governments to be in compliance with this regulation.

Introduction

Crystalline Silica Dust (CSD) is a common workplace occupational health hazard that is created when materials containing silica are ground, pulverized, sawed, drilled, ground, or in some other fashion caused to become airborne. Additionally, abrasive blasting with sand can create CSD exposure. Common materials that contain silica include concrete, brick, stone, ceramics, and rock. CSD particles in size of 5.0 μm or smaller are able to enter the exposed worker's pulmonary system (NIOSH, 2002).

During these activities, the CSD is then inhaled by the worker or others who happen to be exposed to processes that created the CSD, and as a result the CSD enters the body through the respiratory system. The National Institute of Occupational Safety and Health (NIOSH) reports that approximately 1.7 million workers in the United States are potentially exposed to CSD each year (NIOSH, 2002). According to research conducted by Yassin, Yebesi, and Tingle in 2005, the main occupations with CSD exposure include: mining, highway repair, foundry work, agricultural occupations, chemical production, and production of stone, clay, and glass (Yassin, 2005).

The main health threat to workers exposed to CSD is silicosis, which is a pulmonary disease where fibrous nodules develop in the lungs and restrict the flow of air into the body. Other health problems have also been linked to CSD exposure, such as pulmonary tuberculosis, lung cancer, lupus, rheumatoid arthritis, and others. It is estimated that over 250 workers each year in the United States die from silicosis alone, and many more are disabled from silicosis and other diseases related to CSD exposure (Akbar-Khanzadeh, 2002).

In an effort to protect workers from CSD exposure, the Occupational Safety and Health Organization (OSHA) instituted regulations for CSD exposure in both their General Industry and Construction standards. The construction industry standards in 29CFR1926.1153 were enforced beginning on September 23, 2017. The general industry standards listed in 29CFR1910.1053 became law on June 23, 2018.

Health Effects

In 1998, a study was published by Hnizdo and Murray related to CSD exposure. In their study, 2,255 South African gold miners were evaluated for exposure. The participants in the study were gold miners during the years 1968-1971, and the study looked at their health condition in 1995. Hnidzo and Murray were specifically looking to see if pulmonary tuberculosis (PTB) was present with or without radiological signs of silicosis in the pulmonary system.

Hnidzo and Murray discovered that 115 of the miners had developed PTB during that period of time, regardless of whether or not there was also silicosis in the pulmonary system. Therefore, workers exposed to CSD need to be monitored medically not only for silicosis, but also for the emergence of PTB, since both medical conditions can exhibit without the presence of the other, or they can be present together.

Additionally, treating physicians need to be aware that exposed workers may have silicosis with few silicosis nodules in the lungs that very well may not show on radiological scans, yet they still have a high risk of developing PTB. “The results indicate that the silica dust which miners accumulate in their lungs during exposure is a lifelong risk for the development of PTB, even if silicosis is not present in the lungs. Furthermore, even after exposure to dust ends,

ex-miners continue to be at risk of developing silicosis and the development of silicosis places them at even greater risk of developing PTB" (Hnidzo, 1998, p. 501).

A 2003 study by Hnizdo and Vallyathan discovered a correlation between workers with CSD exposure and the development of emphysema and chronic obstructive pulmonary disease (COPD). Post-mortem studies of these individuals revealed that emphysema and COPD were present with or without the associated presence of silicosis, which has also been established to be a result of respiratory toxicity from CSD. As was the case in Hnizdo's 1998 study of South African gold miners, this study revealed that silicosis may not be present radiologically, yet it could be seen in some post-mortem examinations. Additionally, Hnizdo and Vallyathan discovered that "Smoking potentiates the effect of silica dust on airflow obstruction and death from COPD" (Hnizdo, 2003, p. 242).

Chen and colleagues published their study of Chinese workers in 2012. In their study, 74,040 workers who had worked at least one year in metal mines or pottery factories between 1960 and 1974 were observed for health effects from CSD exposure, with the final medical evaluation done in 2003. A comparison was made between these workers and the mortality rates and health conditions of non-exposed individuals (Chen, 2012).

Of those workers studied, 19,516 had died by 2003. The results of the study were that the mortality rate of exposed workers from all causes of death were nearly twice as high as the general population, as well was the incidence of respiratory disease, ischemic heart disease, respiratory tuberculosis, cardiovascular disease, and lung cancer. "Silica dust exposure accounted for 15.2% of all deaths in this study" (Chen, 2012, p. 1). What is most surprising about this study is that this significantly higher mortality rate considered the CSD concentrations that workers were exposed to during their work, and even at concentrations at or below 0.1

mg/m3, the increased mortality rates from the medical conditions listed previously still were accurate. It should be noted that OSHA has set the permissible exposure limit (PEL) at 50 micrograms/m3 based on an 8-hour time weighted average (TWA), which is equal to 0.05mg/m3 (OSHA, 2016).

Yassin and colleagues conducted research on CSD exposure among various industries in the United States during the years 1988-2003. They reiterate the negative health effects of CSD as previously mentioned, with the addition of lupus, renal disease, scleroderma, and Sjogern's syndrome (Yassin, 2005).

According to Yassin, more than 2 million workers are exposed to CSD annually, and of those, 100,000 workers have a high-risk exposure in mining and construction activities. Between the years of 1990-1996, 200-300 deaths in the United States had silicosis as the cause of death listed on the death certificate, which as previously stated is one of the main health hazards of CSD exposure. Yassin's research involved the sampling of air for CSD in various industries and although CSD exposure has decreased in some industries, it has increased in others. According to Yassin, approximately 3.6% of American workers are exposed to CSD levels in excess of the 0.05mg/m3 OSHA PEL, mainly in the occupations of construction, mining, and pipe-fitting (Yassin, 2005). Yassin's research also showed a decrease in CSD exposure for industries when OSHA conducted targeted enforcement of the silica standard, which leads to the conclusion and recommendation that greater enforcement by OSHA will result in a further decline in CSD exposure to American workers.

Akbar-Khanzadeh and Brillhart conducted a study in 2002 at the behest of OSHA to determine what CSD exposure levels were for a specific industry and a specific task; 17 construction workers were evaluated for CSD exposure during concrete finishing operations with

angle grinders. Of the grinders being used, 31% were equipped with local exhaust ventilation (LEV) mechanisms and 69% were not equipped with LEV mechanisms (Akbar-Khanzadeh, 2002).

Although 69% of the air samples taken during the test showed that workers were being exposed to CSD over the OSHA PEL, there were three important findings from this study. First, the grinders with LEV significantly reduced the worker's exposure to CSD. Secondly, ventilation or wind also decreased the exposure. Third, workers that were working upwind of other workers who were doing the same task had lower exposure than those working downwind (Akbar-Khanzadeh, 2002).

Therefore, Akbar-Khanzadeh and Brillhart recommend using tools with LEV capabilities, working upwind, using local ventilation, using wet methods when available, and using administrative controls (reducing exposure times) to reduce exposure (Akbar-Khanzadeh, 2002).

OSHA Silica Standard for General Industry

29CFR1910.1053 is the OSHA CSD standard for general industry and became law and enforceable by OSHA on June 23rd, 2018. Two definitions are necessary to understand the requirements of this standard. First, the Permissible Exposure Limit (PEL) is the maximum amount of CSD that is allowable for an employee to be exposed to. The PEL is 50 μg/m3. The Action Level (AL) is the level of employee exposure where the employer is required to conduct air monitoring to ensure that employees are not exposed to CSD above the PEL. The action level in this regulation is currently 25 μg/m3. It should be noted that the silica dust standard does not apply to an employer where the employer has objective data that the employee will not be exposed to CSD above the action level under any foreseeable conditions (OSHA, 2016).

If the employer does not have objective data that employees will not be exposed above the action level, then the employer is required to conduct air quality exposure assessments of employees. Employers are allowed to do sampling of employees when several employees are doing the same job in the same environment, rather than sampling each individual employee. If the exposure assessment indicates that the exposure is above the AL but below the PEL, then the employer shall re-test within six months. If the results are over the PEL, then the employer shall re-test in three months. If the initial test shows the exposure level to be below the action level, the employer shall re-test in six months. When the employer receives two consecutive test results that are below the action level, the employer can discontinue air monitoring until there is a change in processes or production where the employer can reasonably expect that the CSD exposure level has changed (OSHA, 2016).

For air sampling to be completed by the employer, a certified industrial hygienist will be required to conduct the air sampling using a cyclone air monitoring device. The cyclone will be placed on the employee for eight hours, and the cyclone filters will be sent to a certified lab for testing. For employers who have their own industrial hygienist on-site, they will not need to hire outside help unless desired (OSHA, 2016).

Once the employer has received the results of the air sampling, the employer must notify the employee(s) of the results of the test within fifteen days. If the results of the air sampling exceed the PEL, the employee notification shall also include a written explanation from the employer of the actions planned to be taken to reduce the exposure below the PEL (OSHA, 2016).

The employer shall establish regulated areas when such areas contain CSD exposure over the PEL. The employer is required to demark the areas and restrict access to those areas to

authorized employees, as well as provide respirators to employees and require their usage. The area is required to be posted with a sign with the specific language in 1910.1053(j)(2). In these areas where CSD exposure is over the PEL, the employer is required by this standard to first use engineering and administrative controls to reduce the CSD exposure level as low as possible before implementing the use of personal protective equipment (such as respirators) (OSHA, 2016).

The employer is required to have a written exposure control plan. The plan is required to have, at a minimum, three components. First, it shall list the specific work tasks that involve CSD. Second, it shall list the control methods that the employer is using to reduce employee exposure (engineering, administrative, PPE). Third, the plan shall include the housekeeping measures in place to reduce exposure. Additionally, the plan is required to be reviewed and updated at least annually, and the plan shall be made available to all affected employees when requested (OSHA, 2016).

When respirators are required to be used by employees, the employer is required to implement a respiratory protection program. All respirators used by the employees, as well as the respiratory protection program, must meet the minimum requirements of 29CFR1910.134. The use of respirators does not alleviate the employer of the responsibility to use all feasible engineering and work-practice controls to reduce the CSD exposure as much as possible (OSHA, 2016).

Housekeeping duties in areas of CSD exposure are also required to be addressed by the employer. The employer shall ensure that CSD is not cleaned up using dry sweeping or brushing, unless wet methods or the use of a vacuum with a HEPA filter is not possible. No

compressed air shall be used to clean clothing or surfaces of CSD unless the compressed air is connected to a ventilation system to remove the CSD (OSHA, 2016).

A Medical Surveillance Program must be instituted by the employer to protect the life and health of employees. This program must be made available at no cost to the employee and must be made available to all employees who are exposed to CSD above the PEL for 30 days or more per year (with or without the use of respirators). The program must include an initial examination, follow-up examinations, and any additional examinations where the Physician or Licensed Health Care Professional (PLHCP) has referred the employee to a specialist (OSHA, 2016).

The initial medical examination is required to be conducted within 30 days of the employee's initial assignment to the job where there is CSD exposure and must include: the employee's medical and work history, a physical examination with an emphasis on the pulmonary system, a chest x-ray, a pulmonary function test, and a test for latent tuberculosis. Follow-up examinations must be given at least every three years, or sooner if directed by the PLHCP (OSHA, 2016).

At every medical examination, whether it be with the PLHCP or a specialist, the employer must supply to the physician a copy of 29CFR1910.1053, a detailed list of the employee's duties where they are exposed to CSD, the anticipated exposure level, a description of the PPE that the employee is required to use and that has been supplied by the employer, and any employment-related medical information that the employer has regarding the employee (OSHA, 2016).

A report of the examination's findings must be made from the PLHCP directly to the employee within 30 days of the examination. The report must include the results of the examination, any further medical treatment required due to CSD exposure, any limitations on the use of a respirator or further CSD exposure, as well as any referrals to a specialist for further evaluation or treatment. The PLHCP must also report directly to the employer within 30 days of the examination: the date of the exam, a certification that the exam met the requirements of 29CFR1910.1053, and any limitations of the employee's use of a respirator. With the employee's written consent, the PLHCP will also report to the employer any referrals to specialists for further treatment or evaluation, and any recommendations for further CSD exposure limitations. Any referrals to specialists for further evaluation and treatment require the same exchange of information between the employer, the PHLCP, and the employee, with the same restrictions and time frames as previously indicated (OSHA, 2016).

The silica standard also requires that affected employers integrate CSD into their Hazard Communication (HAZCOM) policy and procedures. Containers containing silica materials must be properly labeled, and safety data sheets for those materials must be made available to all affected employees. The employer will also need to incorporate information regarding CSD exposure into their HAZCOM training program, and the minimum training requirements shall include information regarding cancer, lung damage, effects to the immune system, and renal damage. In addition to this training under the HAZCOM policy and procedure, additional training specific to CSD exposure must be provided to all affected employees to the extent that employees can demonstrate knowledge of the specific job tasks with CSD exposure, the specific control measures that the employer has put in place to reduce the exposure, and the details of the medical surveillance program (OSHA, 2016).

Records of silica monitoring and medical evaluations of employees, including all objective data regarding silica exposure, must be maintained in accordance with 29CFR1910.1020. Air monitoring data must include the following: the date that the air sample was taken, the specific job task that was being monitored, the nature of the sampling method used, the quantity, duration, and results of all samples taken, the name of the laboratory that tested the samples, the type of PPE being worn by the employees at the time of the sampling, and the name, social security number, and job classification of all employees who are represented by the sample (OSHA, 2016).

Recommendations for County Government Compliance

Kansas counties are required to follow OSHA guidelines for safe work practices. Although county governments are not directly under the purview of OSHA, OSHA guidelines are enforced by the Kansas Department of Labor for county governments. Not only is following OSHA guidelines a legal requirement of employers, they are minimum safety standards that help to protect our greatest asset: our employees.

General industry employees are all of the county employees who are not engaged in construction activities, which are the vast majority of employees within the county. The only foreseeable threat to these employees from crystalline silica are the activities of contractors working at county facilities, doing activities that generate silica dust and exposing county employees to the silica dust. The bulk of the silica dust regulations, which are covered separately under 29CFR1926.1153, apply to the Road & Bridge Department, since those employees are engaged in construction activities that may create silica dust.

Regardless of the miniscule threat of CSD exposure to most county employees, the county is still responsible for objectively proving that the workplace is free from this threat. This will require the county to conduct air sampling by an industrial hygienist at all county facilities, at various locations throughout the facility, and having those air samples analyzed by a laboratory for silica content. Once the county can objectively prove, through two consecutive tests administered six months apart, that any silica exposure to employees is below the Action Level, then the rest of the provisions of the silica dust standard will not apply. The county will need to maintain records of all objective air sampling data as indicated in this document, however, as required under 29CFR1910.1020. The county will also need to work with contractors working at county facilities where CSD might be produced by the activities of the contractor to ensure that any CSD generated does not affect employees working at the facility, by requiring the use of tools with local exhaust ventilation and the use of wet methods.

References

Akbar-Khanzadeh, F. & Brillhart, R.L. (2002, April). Respirable crystalline silica dust exposure during concrete finishing (grinding) using hand-held grinders in the construction industry. *The Annals of Occupational Hygiene*, *46*, (3). Retrieved July 22, 2018, from https://academic-oup-com.libproxy.eku.edu/annweh/article/46/3/341/271651

Chen W, Liu Y, Wang H, Hnizdo E, Sun Y, Su L, et al. (2012) Long-Term Exposure to Silica Dust and Risk of Total and Cause-Specific Mortality in Chinese Workers: A Cohort Study. *PLoS Med*, *9*, (4). Retrieved July 22, 2018, from http://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1001206#abstract1

Hnizdo E., & Murray, J. (1998). Risk of pulmonary tuberculosis relative to silicosis and exposure to silica dust in South African gold miners. *Occupational and Environmental Medicine* 1998; 55:496-502. Retrieved July 22, 2018, from https://oem-bmj-com.libproxy.eku.edu/content/55/7/496.citation-tools

Hnizdo, E. & Vallyathan, V. (2003). Chronic obstructive pulmonary disease due to occupational exposure to silica dust: a review of epidemiological and pathological evidence. *Occupational and Environmental Medicine* 2003; 60:237-243. Retrieved July 22, 2018, from https://oem-bmj-com.libproxy.eku.edu/content/60/4/237.citation-tools

National Institute for Occupational Safety and Health. (2017, September). *Silica*. Retrieved July 22, 2018, from https://www.cdc.gov/niosh/topics/silica/

National Institute for Occupational Safety and Health. (2002, April). *Health effects of occupational exposure to respirable crystalline silica.* Retrieved July 22, 2018, from

https://www.cdc.gov/niosh/docs/2002-129/pdfs/2002-129.pdf?id=10.26616/NIOSHPUB2002129

Occupational Safety and Health Administration. (2016, March). *Respirable crystalline silica.* Retrieved July 22, 2018, from https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=1282

Occupational Safety and Health Administration. (2018, February). *OSHA's respirable crystalline silica standard for general industry and maritime.* Retrieved July 22, 2018, from https://www.osha.gov/Publications/OSHA3682.pdf

Occupational Safety and Health Administration. (2016, March). *Workers' exposure to respirable crystalline silica: final rule overview.* Retrieved July 22, 2018, from https://www.osha.gov/Publications/OSHA3683.pdf

Yassin, A., Yebesi, F., & Tingle, R. (2005). Occupational Exposure to Crystalline Silica Dust in the United States, 1988–2003. *Environmental Health Perspectives*, *113*(3), 255–260. Retrieved July 22, 2018, from https://www-ncbi-nlm-nih-gov.libproxy.eku.edu/pmc/articles/PMC1253748/