Respirable Crystalline Silica: Its History, Associated Disease, and the New OSHA Standard—Understanding the New Regulations

The Occupational Safety and Health Administration (OSHA) issued its new silica ruling on June 23, 2015 to take effect one year later. The new ruling (the Final Rule) allows industry from one to five years to comply with most requirements. The Construction Industry must comply by June 23, 2017, while Maritime and General Industry have until June 23, 2018. According to OSHA, the estimated impact of the new ruling translates to more than 600 lives saved and a reduction of more than 900 new cases of silicosis each year. The Final Rule is projected to provide net benefits of about $7.7 billion annually.

There are, of course, opponents to this new regulation who deem the ruling requirements to be not only technologically and economically unfeasible, but also unnecessary. Opponents point to a Centers of Disease Control statistic which states that silica-related deaths have dropped by 93 percent from 1968 to 2007. They also believe OSHA's cost estimate for implementation of the new rule is inaccurate and unrealistic. While OSHA projects the program to cost $511 million for companies to comply, opponents estimate the total costs will tally to nearly $5 billion.[1]

This paper covers:

- Historical background of occupational silicosis
- Industrial sources of silica exposures
- Occupational illnesses caused by silica exposure
- Comparison of the current regulation to the new regulation
- Method to incorporate compliance practices into current Safety & Health Programs
- Free cost-effective resources

The History of Silicosis:

Silicosis is described by many names, among them: chalicosis, dust consumption, flint disease, ganister disease, grave-digger's disease, grinders' asthma, grinders' consumption, grit consumption, knife grinder's phthisis, mason's disease, miner's asthma, miner's phthisis, potters' rot, schistosis, sewer disease, slate worker's disease, and many others.[2]

The first mention of silicosis as a lung disease came as early as the ancient Greeks. Later, several physicians and early industrial hygienists began to write about lung diseases and asthmatic symptoms in miners, and stone cutters in the 16th, 17th, and 18th centuries. By the 1950s, European countries were beginning to outlaw the use of sand containing free silica as an abrasive blasting agent. By 1974, the National Institute of Occupational Safety and Health (NIOSH) recommended the elimination of sand as an abrasive blasting agent in a report, titled, “Criteria for a Recommended Standard: Occupational Exposure to Crystalline Silica.”

Sadly, even though OSHA's Final Rule will protect workers from exposure to respirable crystalline silica, employers in the United States will still be allowed to use sand containing free silica as an abrasive blasting media.

It is this author’s opinion that OSHA realizes that all abrasive media, when broken down into respirable particles, exposes workers to inhalation hazards which can result in injury, illness and even death. While worker exposure to sand has a long and injurious history, it is not the only inhalation hazard from which employers must protect their workers.

Industrial Sources of Silica Exposures:

Silicosis is a lung disease. It occurs when a person inhales respirable-size particles of free silica, the major component of ordinary sand. Sand itself normally does not cause silicosis. Sand becomes hazardous only when it is broken down into respirable-size particles. So, playing on the beach or on a local playground is not considered to be a possible source of silicosis.

Several industrial and construction activities, however, cause silicosis. OSHA published a Fact Sheet citing what the agency believes are the primary industrial, construction and maritime agents of silicosis.
They include:

Industrial:[3]

- Steel and casting foundries during casting cleaning
- Tombstone finishing operations
- Frosting glass
- Sandblasting to prepare surfaces for coating
- Cement and brick manufacturing
- Asphalt pavement and shingle manufacturing

Porcelain and ceramic manufacturing
Tool and die operations
Repair and replacement of refractory brick furnace linings
Manufacturing household abrasives, adhesives, paints, soaps, and glass

Construction:[3]

Sandblasting for paint and rust removal from bridges, concrete structures
Sandblasting of other surfaces
Jack hammering
Rock/well drilling
Concrete mixing
Concrete drilling
Brick and concrete block cutting and sawing
Tuck pointing
Tunneling operations

Maritime:[3]

Sandblasting operations for paint removal and cleaning for surface preparation of steel halls, bulkheads, decks and tanks for paints and coatings.

While OSHA cites the above sources of silica exposure, the agency's compliance trigger to the new standards is an action level of exposure of 25 micrograms per cubic meter to any employee. This is one quarter of the old Permissible Exposure Limit (PEL) of 100 micrograms per cubic meter.

Visualizing a microgram is difficult. To help the reader understand just how small a microgram is, it is helpful to know that an eyelash weighs 75 micrograms, a fly's wing about 50 micrograms, and a period punctuation of ink on paper is about 5 micrograms. With this in mind, it is easy to understand that any time employers have workers performing any one of these activities, they expose not only the person performing the work but also by-standers in the work area to respirable silica at a level above the new OSHA action level.

Occupational Illnesses Caused by Silica Exposure:

While silicosis is a disease caused by the inhalation of silica, it is not the only illness employees may acquire as the result of inhaling silica.

Silicosis is categorized by degree and commonly termed:

Chronic silicosis when it results from long-term exposure to low levels of silica dust. Lifelong sandblasters or other workers exposed for more than 20 years may incur what is commonly known as simple chronic silicosis, which causes swelling of the lungs and chest lymph nodes making it difficult to breathe.

Accelerated silicosis when it is caused by a shorter-length exposure to high amounts of respirable silica. Swelling in the lungs and other symptoms occur within 5 to 15 years of exposure and tend to be more severe.

Acute silicosis, which is the most severe, when it results from short-term exposure to very large amounts of silica. Sandblasters who chose not wear or were not provided with the proper NIOSH-approved type-CE respirators are potential candidates for acute silicosis. This condition causes the lungs to become very inflamed and filled with fluid, causing severe shortness of breath and low-blood-oxygen levels.

While agreement is not universal that silicosis can lead to other health problems, there is medical and clinical evidence that suggest that the following diseases are commonly associated with silicosis:

Connective tissue and massive fibrosis disease—such as rheumatoid arthritis, scleroderma and lupus—are cited as diseases associated with silica exposure by the US National Library of Medicine/National Institutes of Health[4].

Crystalline silica has been classified as a human carcinogen by the International Agency for Research on Cancer. There is also data linking exposure to the combination of silica and smoking to cancer. While the link to smoking may be of interest to some people, the predominant research links Lung Cancer and Silicosis.[5]

Silica-dust-associated tuberculosis (TB) is the result of mycobacterial infection in silica-exposed individuals. While silica-dust-associated tuberculosis is more prevalent in developing countries, there is enough evidence to conclude that it is a disease related to worker exposure to silica.[6]

Comparing the Old (Current) Regulation to the New Regulation:

Prior to the new silica standard issued on June 23, 2016, there was no single specific standard addressing silica exposure. Silica enforcement has been dependent upon several existing regulations. The new standard is involves two regulations, they are:

29CFR 1910.1053: Titled: Respirable Crystalline Silica, written for General and Maritime Industries
29CFR 1926.1153: Titled: Respirable Crystalline Silica, written for the Construction Industry

OSHA is allowing a grace period before enforcement will begin. This grace period is provided to allow employers ample time to comply. The enforcement dates are:

Construction	June 23, 2017
General Industry	June 23, 2018
Maritime	June 23, 2018
Hydraulic Fracking	June 23, 2018, *except Engineering Controls (compliance by June 23, 2021).*

Changes between the old and new regulations include:

- Scope
  - New action and permissible exposure levels are set at approximately half of the old levels. The new exposure levels are:
    - Action Level: 25µg/m^3
    - Permissible Exposure Level: 50µg/m^3
- Exposure Control Methods
  - The Construction Standard allows the employer to follow the Engineering and Work Practice Methods for 18 common silica-dust-generating work activities in lieu of the more onerous requirement to perform an Exposure Assessment.

- Any activity outside the 18 described methods requires the employer to perform a detailed Industrial Hygiene Study on any operation producing silica dust. **Sandblasting** requires this detailed Industrial Hygiene Study.
- The General Industry and Maritime Industry Standards require a detailed Industrial Hygiene Study for all silica-dust-generating activities.

- Regulated Areas
  - The Construction and General and Maritime Industry Standards all require a specific active Hazard Communication, Respiratory, and Medical Monitoring Program which addresses any person exposed to over 50μg/m^3 until June 23, 2018 and 25μg/m^3 by June 23, 2020. The new standard will require the employer to ensure that any employee working around a sandblaster be included in this program.
  - The General and Maritime Industries will be required to post specific signage around the areas where there is any possibility of exceeding 25μg/m^3 and restrict access to these areas.

- Housekeeping
  - The dry sweeping of silica dust will no longer be allowed and wet sweeping or vacuuming alternatives will have to be implemented.
  - Using compressed air to blow off employee clothing will no longer be allowed and alternate means, such as air-wash showers, will have to be used in place of compressed air.

- Written Exposure Control Plan
  - The Written Exposure Control Plan is a new requirement promulgated by this standard. It covers all the industries in the same manner. The plan must:
    - Describe all the processes which produce silica dust
    - Describe the engineering controls, work practices, and respiratory protection to limit employee exposure to silica dust
    - Describe the housekeeping measures in place to reduce exposure
    - Include an annual review of the plan
    - Provide access to the plan by all affected employees

- Medical Surveillance
    - Medical Surveillance is the most complex element of the new standard. All but very large employers will likely choose to contract this activity to a qualified occupational medical facility. This portion of the standard requires:

        - Initial examination of all affected employees
        - Medical and work histories
        - Chest X-ray and B-read from a certified NIOSH B-reader
        - Pulmonary function testing
        - Testing for tuberculosis infection
        - Retesting at least every 3 years
        - Written medical reporting for every affected employee
        - Written medical opinion issued to the employer

        Employers should pay attention to the requirement for any individual receiving a B-read of greater than 1/0 to be examined by a specialist.

        By definition, a B-read of 1/0 is “likely 1st level of opacities but x-ray may be normal.” This provision in the standard will require the majority of workers to be seen by a specialist.

- Recordkeeping:
    - The standard requires employers to maintain records on all air monitoring, employee training, and medical surveillance.

The table below compares the OSHA regulations prior to and after implementation of OSHA's new Construction and General Industry and Maritime Regulations:

Item	Enforcement Action **Prior** to New Silica Standard		Enforcement Action **After** New Silica Standard	
Scope				
Action Level	None		25 µg/m^3	1910.1053(a)(2)
			25 µg/m^3	1926.1153(a)
Exposure Control Methods				
PEL	10mg/m^3 (%SiO_2+2)	1910.1000(c)	50 µg/m^3	1910.1053(b)(d)
	250mppcf (%SiO_2+5)	1926.55 1926.57(2)(ii)	50 µg/m^3	1926.1153(d)(1)
Specific Methods	None		Table 1 Lists 18 Specific Methods to Control Exposure	1926.1153(c)(1)
Nonspecific Methods	General Requirements	1910.94(a)(5)(ii)(b) 1910 Subpart I	Exposure Assessment Performance Option Scheduled Option	1910.1053(d)(1) 1910.1053(d)(2) 1910.1053(d)(3)
	General Requirements	1926.57(f) 1926.103(1910.134)	Exposure Assessment Performance Option Scheduled Option	1926.1153(d)(2)(i) 1926.1153(d)(2)(ii) 1926.1153(d)(2)(iii)
Employee Notification	General Requirements	1910.134 1910.1000	Within 15 days of Exposure Assessment	1910.1053(d)(6)
	General Requirements	1926.57(f) 1926.103(1910.134)	Within 5 days of Exposure Assessment	1026.1153(d)(2)(vi)
Employee Rep.	General Requirements	1903 1904.35	Observation of Monitoring by Emp. Rep.	1910.1053(d)(7)
	General Requirements	1903 1904.35 1910.1020	Observation of Monitoring by Emp. Rep.	1926.1153(d)(2)(vii)
Demarcation (Post Signs, Limit Access)	None		Post Signs and Limit Access	1910.1053(e)(1) 1910.1053(e)(2) 1910.1053(e)(3)
Methods of Compliance	General Requirements	1910.134(a)(1)	Shall use Engrg and Work Practice Controls	1910.1053(f)
	General Requirements	1926.103 (1910.134(a)(1))	Shall use Engrg and Work Practice Controls	1926.1153.(d)(3)(i)
Sandblasting Provisions	Ventilation	1910.94 1915.34 1915.Subpar I	Standard Reinforces Prior Standards	1910.1053(f)(3)

Item	Enforcement Action **Prior** to New Silica Standard		Enforcement Action **After** New Silica Standard	
	Ventilation	1926.57(f)	Standard Reinforces Prior Standards	1926.1153(d)(ii)
Respiratory Protection	General Requirements	1910.134	Standard Reinforces Prior Standards	1910.1053(g)
	General Requirements	1926.103(1910.134)	Standard Reinforces Prior Standards	1926.1153(e)
			Exempts Emp. from 1910.134(d)(1)(iii) &(d)(3) When Using Table 1	1926.1153(e)(3)
Housekeeping	General Requirements	1910.22 1910.141 1915.81	Replaces Dry Sweeping with Wet Sweeping/Vacuuming	1910.1053(h)(1)
			Prohibits the use of compressed air to blow down clothing	1910.1053(h)(2)
	General Requirements	1926.25	Replaces Dry Sweeping with Wet Sweeping/Vacuuming	1926.1153(f)(1)
			Prohibits the use of compressed air to blow down clothing	1926.1153(f)(2)
Written Exposure Plan	None		Develop a Written Exposure Plan, Including: Description of Silica Exposure, Task, Engrg Controls, Work Practices, Resp. Protection, Housekeeping and Annual Review	1910.1053(f)(2)
			Develop a Written Exposure Plan, Including: Description of Silica Exposure, Task, Engrg Controls, Work Practices, Resp. Protection, Housekeeping and Annual Review	1926.1153(g)

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Item	Enforcement Action **Prior** to New Silica Standard		Enforcement Action **After** New Silica Standard	
Medical Surveillance	None		General Initial Examination Medical History Physical Exam X-Ray Pulmonary Function Test Retesting (Every 3 yrs.) Emp. Work History Medical Report Recordkeeping Emp. Notification	1910.1053(i)(1) 1910.1053(i)(2) 1910.1053(i)(2)(i) 1910.1053(i)(2)(ii) 1910.1053(i)(2)(iii) 1910.1053(i)(2)(iv) 1910.1053(i)(3) 1910.1053(i)(4) 1910.1053(i)(5) 1910.1053(i)(6) 1910.1053(i)(6)iii
			General Initial Examination Medical History Physical Exam X-Ray Pulmonary Function Test Retesting (Every 3 yrs.) Emp. Work History Medical Report Recordkeeping Emp. Notification	1926.1153(h)(1) 1926.1153(h)(2) 1926.1153(h)(2)(i) 1926.1153(h)(2)(ii) 1926.1153(h)(2)(iii) 1926.1153(h)(2)(iv) 1926.1153(h)(3) 1926.1153(h)(4) 1926.1153(h)(5) 1926.1153(h)(6) 1926.1153(h)(6)iii
Hazard Communication	General Requirements	1910.1200	Include all the elements of HCS, in addition to informing Emp. of Cancer, Lung/Immune/Kidney Effects	1910.1053(j)(1)
			Post signs stating: (Danger … See Standard) defining Area in excess of 50µg/m^3	1910.1053(j)(2)
			Emp. must demonstrate Knowledge of: Health, and Workplace Hazards, Protective Measures, Medical Surveillance. Program	1910.1053(j)(3)
	General Requirements	1925.59 (1910.1200)	Include all the elements of HCS, in addition to informing Emp. of Cancer, Lung/Immune/Kidney Effects	1926.1153(i)(1)

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Item	Enforcement Action **Prior** to New Silica Standard		Enforcement Action **After** New Silica Standard	
			Emp. must demonstrate Knowledge of: Health, and Workplace Hazards, Protective Measures, Medical Surveillance Program	1926.1153(i)(2)
Recordkeeping	General Requirements	1904 1910.1200	Air Monitoring Data Objective Data Medical Surveillance Hazard Communication	1910.1053(k)(1) 1910.1053(k)(2) 1910.1053(k)(3) 1910.1053(j)
	General requirements	1904 1925.59 (1910.1200)	Air Monitoring Data Objective Data Medical Surveillance Hazard Communication	1926.1153(j)(1) 1926.1153(j)(2) 1926.1153(j)(3) 1926.1153(i)
Target Dates	None		Effective date General & Maritime, Fracking Compliance Medical Surveillance, above 50µg/m^3 Medical Surveillance Above 25µg/m^3 Fracking Engrg Controls	June 23, 2016 June 23, 2018 June 23, 2018 June 23, 2020 June 23, 2021
	None		Effective Date General Requirements Sample Analysis	June 23, 2016 June 23, 2017 June 23, 2018

Integrating Compliance Practices into an Existing Safety and Health Program:

Integrating the new silica standard into an Environmental Health and Safety Program is no small task; but there are choices to be made:

Employers with industrial operations should take a serious look at changing abrasive/media as a solution for compliance with this new standard. Sand is an inexpensive single-cycle abrasive. While there are many available alternative abrasives/media options, at face value none will appear to be as inexpensive as sand. Recyclable abrasives/media, however, offer industrial users considerable value and cost-savings. Recyclability ranges from several to hundreds of cycles of use.

While a blast cabinet or blast room requires an initial capital investment, it can quickly pay for itself from labor savings achieved by convenience and abrasive cost through the use of recyclable media. Enclosing blasting and using recyclable media eliminate the need to comply with the new regulatory standards.

Industry employers currently treating or cutting small components or surfaces with sand or media containing crystalline silica can opt to perform these functions in a blast cabinet. Containing the blast process in a blast cabinet isolates workers from silica dust and eliminates the need to comply with the standard.

If material substitution or the use of an abrasive blast room or cabinet is NOT an option, then General Industry employers will have to fully implement the standard as written.

The standards for Construction and General Industry are very similar with the exception that the Construction standard allows for the employer to implement "specified exposure control methods" for 18 common silica-dust-producing operations found in construction. If the construction employer follows these control guidelines, there is no need to implement the extensive requirements found in paragraph "d" of the standard. This paragraph is titled, "Alternate Exposure Control Methods." The General Industry standard equivalent can be found starting in paragraph "d," titled "Exposure Assessment."

The best and easiest way to comply with the "Alternate Exposure Control Methods" or "Exposure Method," is to hire a Certified Safety Professional or Industrial Hygienist to develop and implement the entire program. A consultant in your area can be found at all of the following websites:

- http://www.manta.com/mb_35_A62E68C0_000/safety_consultants
- https://www.dmoz.org/Health/Occupational_Health_and_Safety/Consultants/United_States/
- https://www.osha.gov/dcsp/smallbusiness/consult.html

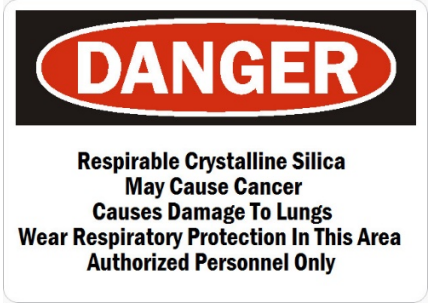
If the employer should elect to develop, write, implement, and maintain the new Silica Standard, the following information may be helpful.

Step One toward the development of a compliant Silica Program is to perform an "Exposure Assessment," which includes:

- A detailed list and description of every job which has the potential of generating hazardous silica dust. This job list must include a step-by-step description of how the job is performed, the tools and materials used for the job, and the housekeeping measures that will eliminate or significantly reduce dust.
- A list of employees with job title indicating how they may be exposed to silica dust exceeding the action level of 25µg/m^3, over 30 days a year.
- Air monitoring of each of the above listed employees to determine their 8-hour TWA exposure, or

- Air monitoring in a representative area which exceeds 25µg/m^3, to delineate exposed areas from areas below the action level. If the air monitoring option is chosen, it must be performed every 6 months. If the exposure level is found to be above 50µg/m^3, monitoring must be repeated in 3 months. For any areas that are reclassified as being below the action level, monitoring must be repeated twice, seven days apart.
- Sampling must be done in compliance with Appendix A of the standards. For the sake of brevity, I suggest you consider Galson Labs to obtain your sampling equipment and procedures to perform compliant sampling and reports. Galson Labs may be found at:
    - http://www.sgsgalson.com/
- All monitoring activities must be performed with an employee representative present. The representative is allowed to assist in the monitoring. All information must always be made available to all affected employees.

Step Two toward development of a compliant program is to delineate areas which expose employees to over 25µg/m^3. While the Construction Industry is not required to post signs, General Industry must post the following specific sign at the entry area:



Step Three is to provide documented training to all affected personnel. This requirement ensures and demonstrates employee knowledge of the hazards associated with silica dust exposure and may be integrated into an existing Hazard Communication Program.

Step Four is to identify and provide proper respiratory protection for any employee within the affected area exposed to over 50µg/m^3 of crystalline silica. The standard allows for negative pressure respirators, (ie: dust masks) for most activities except for higher dust-producing activities, such as abrasive blasting, which require a type-CE supplied-air respirator. Employees using respirators as a result of this new silica standard must be integrated into the employer's existing Respirator Program.

Step Five involves medical monitoring. The elements of medical monitoring were covered above. The elements of the standards likely need to be accomplished by contract to an Industrial Medical Facility. Check with the medical provider performing your current hearing and respirator testing. Chances are they will be able to provide compliant silica monitoring, and assist with maintaining these medical records.

Free Cost-effective Resources:

Implementing and complying with the new Respirable Crystalline Silica Standard are complex, difficult, and expensive tasks. Employers should, at a minimum, reevaluate the type of abrasive they are using, and the equipment referenced in Table 1 of the Construction Standard. They should hire a qualified safety professional to develop, write, train, and implement the elements of these new standards, and expand their current medical monitoring from the current hearing and respiratory requirements to include all elements of this new standard.

Sources of consultants are cited above. Employers wishing to bring in-house as much of the compliance activities as possible can refer to the following websites for support, available either free-of-charge or at a minimal cost:

- https://www.osha.gov/dcsp/smallbusiness/consult.html
    - OSHA provides an active consultant program for free. This website can assist employers with contracting for this free service.

Crystalline Silica for Construction and General Industry Training can be purchased from several on-line sources or from software companies, including:

- https://www.jjkeller.com
- http://safetytrainingresources.com

Whether the new Respirable Crystalline Silica Standard will cost employers $500 million as OSHA estimates or $5 billion as its opponents fear, the new standard will have significant impact on the use of silica sand as an abrasive.

The new standard will also impact the equipment chosen to cut and modify existing structures containing silica sand, and the cost of every employer's Environmental Safety and Health Program.

While these regulations go a long way to protect workers from crystalline silica dust, inhalation hazards associated with the numerous other abrasives and toxic dusts remain and likely are equally dangerous to the exposed employees.

In this writer's opinion, OSHA should take a more all-encompassing approach to workplace inhalation hazards rather than addressing each one in a piece-meal manner.

[1] *OSHA's Final Rule to Protect Workers from Exposure to Respirable Crystalline Silica, 5/16, OSHA.gov, 7/16*

[2] *THE MANY NAMES OF SILICOSIS, 1/16, ROSINCERATE.COM, 7/16*

[3] *Crystalline Silica Exposure Health Hazard Information, 1/02, OSHA.gov, 7/16*

[4] *Silica associated mixed connective tissue disorder in a stone crusher, Indian Journal of Occupational & Environmental Medicine, 5/13, ncbi.nlm.nih.gov, 7/16*

[5] *Exposure-Response Analysis and Risk Assessment for Lung Cancer in Relationship to Silica Exposure, American Journal of Epidemiology, 2013, medscape.com, 7/16*

[6] *Silica, Silicosis and Tuberculosis, US National Library of Medicine/National Institutes of Health, 5/07, ncbi.nlm.nih.gov, 7/16*