# Air Sampling for Silica with Aluminum Cyclone for Comparison to Occupational Exposure Limits

FACT SHEET 55-020-0311

## *Background*

This document will outline how to conduct air sampling for crystalline Silica for comparison with the occupational exposure limits (OELs) in the OSHA standard and the ACGIH TLV guidelines. This document does not cover sampling for Army or Environmental Protection Agency (EPA) silica environmental levels. Silica's chemical name is silicon dioxide for ($SiO_2$) and it is the most common mineral found in the earth's crust. Silica is most commonly found in nature as sand or quartz, but it is also found in living things such as the walls of diatoms. Silica is used in industry to make glass, optical fibers, ceramics, and Portland cement; it is also a common additive in foods and is used in water filtration. Because silica is so common in nature and in industry, we are exposed to significant amounts of it on a daily bases in our food, water and air. Silica comes in several different crystal structures and it is the crystalline structures that are associated with elevated health risk for exposures. Exposures to respirable sizes of crystalline silica over long periods of time can lead to silicosis and bronchitis which are obstructive fibrosis lung diseases or pneumoconiosis. There is also some evidence that exposure to crystalline silica can lead to lung cancers.

## *The OEL for Crystalline Silica*

There are two occupational exposure limits (OELs) for crystalline silica. One is the ACGIH eight hour time weighted average (TWA) TLV for $SiO_2$ of 0.025 milligrams per cubic meter of air ($mg/m^3$) (reference 4). The second OEL is the OSHA eight hour TWA PEL for $SiO_2$ is a formula were the PEL = (10 $mg/m^3$) divided by the (% silica + 2) (reference 3). The Army requires in DA PAM 40-11 (reference 5) that we use the most protective OEL. To determine which standard is more protective we must first calculate the OSHA PEL. Therefore, if we assume worst case for the OSHA PEL where the sample is 100% $SiO_2$ the calculated PEL would be 0.098 $mg/m^3$, which is less protective then the ACGIH TLV of 0.025 $mg/m^3$. Therefore the Army would require that we meet the ACGIH TWA TLV for $SiO_2$. Please note that both OELs require that we compare only the respirable fraction of the dust to the OEL. The definition of respirable dust fraction sampling can be found in reference 4, Appendix C: Particle Size-Selective Sampling Criteria for Airborne Particulate Matter.

## *Sampling for Crystalline Silica*

The sampling method used by the Army is outlined in USAPHC (Prov) TG 141 (reference 1), which is a modified version of the NIOSH 7500 method (reference 2). The samples are collected on 37 millimeter (mm), 5 micron pore size, pre-weighted or matched weight polyvinyl chlorinated (PVC) filter with a size selector pre-stage. The pre-stage size selector removes all the dust that does not meet the requirements of respirable dust from the airstream before it gets to the filter. In the case of this fact sheet we are using a 10 mm aluminum cyclone (see Figure 1 below). The aluminum cyclone requires that we use a flow rate of 2.5 liters per minute (l/min) in order to insure that we are only collecting respirable size fraction of the dust on the filter. The method recommends that we collected a sample volume of 400 to 1000 liter. If a different size selection device is used a different flow rate would be required. The flow rates of the pump and sampling train must be calibrated as a unit (see Figure 2 below).

To use the aluminum cyclone you first remove the inlet cover to the PVC filter and replace it with the cyclone, the cyclone is then placed in a cyclone/filter holder. The filter holder is then placed on the worker in the breathing zone or hung in the area at workers breathing zone height of about five to six feet from the working surface. It is important for the proper operation of the cyclone for the sample trains to be hung so that the cyclone is in the vertical position and be allowed to swing freely on the workers, so that the cyclone can maintain that ordination. If the cyclone grid pot (hopper) gets higher than the filter, all the material collected in the hopper can travel to the filter, which would negate the sample.

You must calibrate the sample train as one unit, which can be performed in one of two ways, the first way is to use a calibration adapter for the aluminum cyclone (see Figure 3 below) or use a calibration jar (see Figure 4 below). To use the aluminum cyclone calibrator, place the calibrator over the stem of the cyclone and then connecting the nipple on the bottom of the calibrator to your flow rate measurement device. The suction side of the filter is then attached to the pump. The pump is then turned on and the flow rate measured on your device, you then change the

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pumps flow rate until it gets to 2.5 l/min. The second way to calibrate the sampling train is to use a calibration jar by placing the sampling train into the jar, the suction side of the sampling train is attached to one of the nipples on the cover of the jar and then to the sampling pump. The top is then placed on the jar and tightened to make the jar air tight and then the other nipple on the jar is connected to your flow rate measurement device. The pump is then turned on and the flow rate measured on your device, you then change the pumps flow rate until it gets to 2.5 l/min.

Remember that it is important that the flow rate of the sampling train equals 2.5 l/min for the system to work properly. However if you use something other than an aluminum cyclone as your size selector then you must use that devices required flow rate.

After the samples have been collected they should be submitted to the USAPHC (Prov) Laboratory for analysis by x-ray diffraction method. In addition to the samples collected, you need to provide the lab with two field blanks and two media blanks for the first ten samples, plus two additional blanks (one media one field) for every additional ten samples. Field blanks are handled like the actual sample except that no air is pulled through the filters, media blanks are not opened.


Figure 1. Recommended Silica Sampling Train

Figure 3. Aluminum Cyclone Calibrator

For additional assistance or questions concerning this fact sheet, please contact Mr. Ralph W. Rogers at commercial 410-436-3118, DSN 312-584-3118, or email at ralph.rogers@us.army.mil

### *References*


*1. U.S. Army Public Health Command (Provisional) (USAPHC (Prov)) Technical Guide (TG) 141, Industrial Hygiene Sampling Guide, October 2010.*

*2. National Institute for Occupational Safety and Health (NIOSH), Manual of Analytical Methods, 4th Edition, 1994, Peter M. Eller, Editor, (NIOSH Publication No. 94-113. 1994.)*

*3. Occupational Safety and Health Administration (OSHA) Air Contaminate Standard, Title 29 Code of Federal Regulations (CFR) Part 1910.1000 and Part 1926.55, most current edition.*

*4. 2009 Threshold Limit Values (TLVs®) for Chemical Substances and Physical Agents & Biological Exposure Indices (BEI), American Conference of Governmental Industrial Hygienists (ACGIH), 2009.*

*5. Department of the Army Pamphlet (DA Pam) 40-11, Preventive Medicine, 22 July 2005*




Figure 2. Aluminum Cyclone

Figure 4. Calibration Jar