OVERVIEW OF SILICA AS A HEALTH HAZARD

OVERVIEW OF HEALTH HAZARDS IN CONSTRUCTION

Examples found in construction

Examples of substances found in construction which cause respiratory effects include asphalt fumes, carbon black, fibrous glass, iron oxides, dust and fumes (from welding and abrasive blasting), mineral wool fiber, nitrogen dioxide (from engine exhaust), ozone, silica, and wood dust.

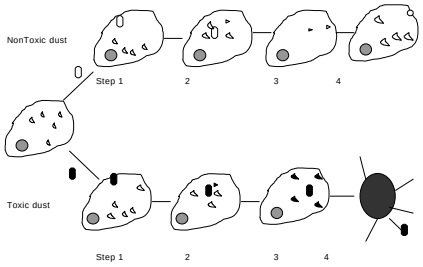
Substance	Total exposed FTE (person years)	FTE exposed above PEL (person years)
Silica quartz (crystalline)	**852083**	**30583**
Silica cristobalite	68938	11783
Nickel, soluble	20137	2139
Asphalt fume	300786	1643
Fibrous glass	180484	498
Wood dust (hard wood)	152322	304
Wood dust (soft wood)	395217	189

Background

Silica exposure remains a serious threat to nearly 2 million U.S. workers

In October 1996, the International Agency for Research on Cancer classified crystalline silica as "carcinogenic to humans."

Exposure studies indicate that some workers are still exposed to very high levels of silica



Cellular response to dust particles deposited in the lung. The cell depicted is an alveolar macrophage.

In the case of the **nontoxic particle** (upper pathway), the ingested particle is surrounded by primary lysosomes, which excrete enzymes to dissolve the particle. The particle may be dissolved completely, partly dissolved and excreted from the cell, or retained in the cell.

In the case of a **toxic particle such as silica** (lower pathway), the cellular response is the same, but the cell cannot dissolve the particle, and the cell eventually dies. The contents of the cell including the enzymes, and the unchanged particle, are released into the lung.

The resulting damage can be a fibrotic response leading to conditions such as silicosis.

Complications

Initially, workers with silicosis may have no symptoms.

As silicosis progresses, there may be difficulty in breathing and other chest symptoms such as cough. Infectious complications may cause fever, weight loss, and night sweats.

Severe mycobacterial or fungal infections can complicate silicosis and may be fatal.

- Medical evaluations of silicosis victims usually show the lungs to be filled with silica crystals and a protein material
- NIOSH concluded that occupational exposures to respirable crystalline silica are associated with the development of silicosis, lung cancer, pulmonary tuberculosis, and airways diseases. These exposures may also be related to the development of autoimmune disorders, chronic renal disease, and other adverse health effects.

Types of Silicosis

A worker may develop any of three types of silicosis, depending on the airborne concentration of crystalline silica:

Chronic silicosis, which usually occurs after 10 or more years of exposure to crystalline silica at relatively low concentrations

Accelerated silicosis, which results from exposure to high concentrations of crystalline silica and develops 5 to 10 years after the initial exposure

Acute silicosis, which occurs where exposure concentrations are the highest and can cause symptoms to develop within a few weeks to 4 or 5 years after the initial exposure

Table 2. Personal Measurements Summarized by Trade
(Each measurement includes both respirable dust and respirable silica).

Trade	Job Title(s)	Meas. (N)	Workers (K)	Workers with Repeat Meas.	No. Meas. per Worker	No. Meas. < LOD
PA	Painter & Painter Helper	14	12	2	1–3	2[a]
BL	Bricklayer & Bricklayer/PLC[b]	11	8	3	1–3	4[a]
OE	Operating Engineer	46	23	13	1–6	13[a]
LA	Laborer & Drill Runner	80	37	17	1–7	12[a]

Table 3. Median Levels and Ranges of Respirable Dust and Silica Exposures for Workers in Four Construction Trades

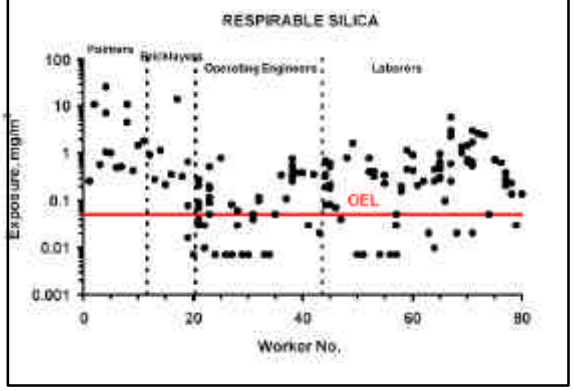
		Dust (mg m^{-3})			Silica (mg m^{-3})		
Trade	N	Median	Range	Max/Min	Median	Range	Max/Min
PA	14	13.5	1.10–873	718	1.28	0.260–26.2	101
BL	11	2.13	0.160–29.0	181	0.320	0.007–14.2	2020
OE	46	0.720	0.01–3.60	360	0.075	0.007–0.840	114
LA	80	2.46	0.01–21.0	210	0.350	0.007–5.90	843

Legend: PA = painters; BL = bricklayers; OE = operating engineers; LA = laborers; N is the number of measurements.

Table 5. Results of Testing Overexposure for Respirable Dust and Respirable Silica among 4 Construction Trades.
[Based upon parameters estimated under Model (1)]

Trade	Contaminant	Model	OEL (mg m^{-3})	$\beta_{1,0}$	θ_0	$\hat{\gamma}$	C_α	Decision
PA	Dust	Full	5	90.5	0.892	4.89*	–1.96	Unacc.
	Silica	Red.	0.05	3.86	1.000	8.13*	–1.96	Unacc.
BL	Dust	Full	5	8.26	Und.	1.28	–6.16	Unacc.
	Silica	Red.	0.05	2.71	0.907	4.05*	–1.96	Unacc.
OE	Dust	Full	5	1.44	0.102	–0.166*	–1.96	Unacc.
	Silica	Red.	0.05	0.216	0.643	4.04*	–1.96	Unacc.
LA	Dust	Full	5	6.09	0.297	3.88*	–1.96	Unacc.
	Silica	Red.	0.05	0.918	0.801	9.17*	–1.96	Unacc.

Legend: BL = bricklayers; PA = painters; OE = operating engineers; LA = laborers; OEL is the occupational exposure limit (mg m^{-3}); $\hat{\beta}_{1,0}$ represents the estimated mean of the exposure concentration of the field study, with units of (mg m^{-3}); $\hat{\theta}_0$ represents the estimated probability of overexposure of the field study; $\hat{\gamma}$ is the test statistic; C_α is the critical value at an $\alpha = 0.05$ level of significance; Unacc. indicates that exposure is unacceptable ($\hat{\gamma} > C_\alpha$); Und. – indicates that $\hat{\theta}_0$ is undefined under Equation (3) when $\hat{\theta}_{1,0} = 1$.



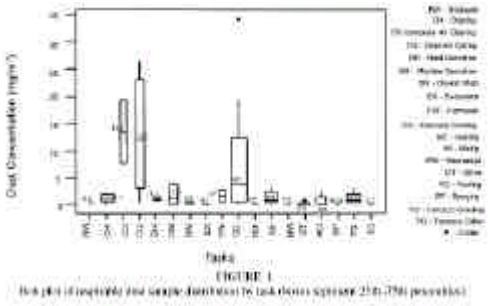


FIGURE 1

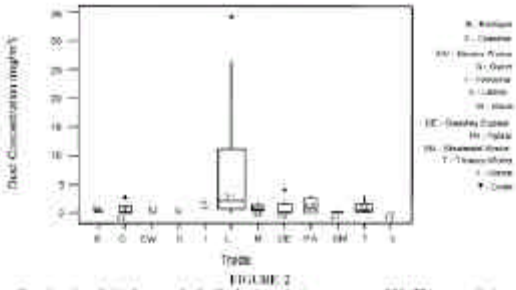


FIGURE 2

Breathing Zone Aerosol Levels (<10 µm diameter) - Mortar Removal with Saw