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Silica in Construction:

An Interdisciplinary Annotated Bibliography

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Silica: An Interdisciplinary Annotated Bibliography

Akbar-Khanzadeh, F., et al. (2013). "Task-specific noise exposure during manual concrete surface grinding in enclosed areas-influence of operation variables and dust control methods." J Occup Environ Hyg 10(9): 478-486.

Noise exposure is a distinct hazard during hand-held concrete grinding activities, and its assessment is challenging because of the many variables involved. Noise dosimeters were used to examine the extent of personal noise exposure while concrete grinding was performed with a variety of grinder sizes, types, accessories, and available dust control methods. Noise monitoring was conducted in an enclosed area covering 52 task-specific grinding sessions lasting from 6 to 72 minutes. Noise levels, either in minute average noise level (Lavg, dBA) or in minute peak (dBC), during concrete grinding were significantly ($P < 0.01$) correlated with general ventilation (GV: on, off), dust control methods (uncontrolled, wet, Shop-Vac, HEPA, HEPA-Cyclone), grinding cup wheel (blade) sizes of 4-inch (100 mm), 5-inch (125 mm) and 6-inch (150 mm), and surface orientation (horizontal, inclined). Overall, minute Lavg during grinding was 97.0 +/- 3.3 (mean +/- SD), ranging from 87.9 to 113. The levels of minute Lavg during uncontrolled grinding (98.9 +/- 5.2) or wet-grinding (98.5 +/- 2.7) were significantly higher than those during local exhaust ventilation (LEV) grinding (96.2 +/- 2.8). A 6-inch grinding cup wheel generated significantly higher noise levels (98.7 +/- 2.8) than 5-inch (96.3 +/- 3.2) or 4-inch (95.3 +/- 3.5) cup wheels. The minute peak noise levels (dBC) during grinding was 113 +/- 5.2 ranging from 104 to 153. The minute peak noise levels during uncontrolled grinding (119 +/- 10.2) were significantly higher than those during wet-grinding (115 +/- 4.5) and LEV-grinding (112 +/- 3.4). A 6-inch grinding cup wheel generated significantly higher minute peak noise levels (115 +/- 5.3) than 5-inch (112 +/- 4.5) or 4-inch (111 +/- 5.4) cup wheels. Assuming an 8-hour work shift, the results indicated that noise exposure levels during concrete grinding in enclosed areas exceeded the recommended permissible exposure limits and workers should be protected by engineering control methods, safe work practices, and/or personal protective devices.

Akbar-Khanzadeh, F., et al. (2007). "Crystalline silica dust and respirable particulate matter during indoor concrete grinding - wet grinding and ventilated grinding compared with uncontrolled conventional grinding." J Occup Environ Hyg 4(10): 770-779.

The effectiveness of wet grinding (wet dust reduction method) and ventilated grinding (local exhaust ventilation method, LEV) in reducing the levels of respirable crystalline silica dust (quartz) and respirable suspended particulate matter (RSP) were compared with that of uncontrolled (no dust reduction method) conventional grinding. A field laboratory was set up to simulate concrete surface grinding using hand-held angle grinders in an enclosed workplace. A total of 34 personal samples (16 pairs side-by-side and 2 singles) and 5 background air samples were collected during 18 concrete grinding sessions ranging from 15-93 min. General ventilation had no statistically significant effect on operator's exposure to dust. Overall, the arithmetic mean concentrations of respirable crystalline silica dust and RSP in personal air samples during: (i) five sessions of uncontrolled conventional grinding were respectively 61.7 and 611 mg/m(3) (ii) seven sessions of wet grinding were 0.896 and 11.9 mg/m(3) and (iii) six sessions of LEV grinding were 0.155 and 1.99 mg/m(3). Uncontrolled conventional grinding generated relatively high levels of respirable silica dust and proportionally high levels of RSP. Wet grinding was effective in reducing the geometric mean concentrations of respirable silica

dust 98.2% and RSP 97.6%. LEV grinding was even more effective and reduced the geometric mean concentrations of respirable silica dust 99.7% and RSP 99.6%. Nevertheless, the average level of respirable silica dust (i) during wet grinding was 0.959 mg/m(3) (38 times the American Conference of Governmental Industrial Hygienists [ACGIH] threshold limit value [TLV] of 0.025 mg/m(3)) and (ii) during LEV grinding was 0.155 mg/m(3) (6 times the ACGIH TLV). Further studies are needed to examine the effectiveness of a greater variety of models, types, and sizes of grinders on different types of cement in different positions and also to test the simulated field lab experimentation in the field.

Akbar-Khanzadeh, F., et al. (2010). "Effectiveness of dust control methods for crystalline silica and respirable suspended particulate matter exposure during manual concrete surface grinding." J Occup Environ Hyg 7(12): 700-711.

Concrete grinding exposes workers to unacceptable levels of crystalline silica dust, known to cause diseases such as silicosis and possibly lung cancer. This study examined the influence of major factors of exposure and effectiveness of existing dust control methods by simulating field concrete grinding in an enclosed workplace laboratory. Air was monitored during 201 concrete grinding sessions while using a variety of grinders, accessories, and existing dust control methods, including general ventilation (GV), local exhaust ventilation (LEV), and wet grinding. Task-specific geometric mean (GM) of respirable crystalline silica dust concentrations (mg/m(3) for LEV:HEPA-, LEV:Shop-vac-, wet-, and uncontrolled-grinding, while GV was off/on, were 0.17/0.09, 0.57/0.13, 1.11/0.44, and 23.1/6.80, respectively. Silica dust concentrations (mg/m(3) using 100-125 mm (4-5 inch) and 180 mm (7 inch) grinding cups were 0.53/0.22 and 2.43/0.56, respectively. GM concentrations of silica dust were significantly lower for (1) GV on (66.0%) vs. off, and (2) LEV:HEPA- (99.0%), LEV:Shop-vac- (98.1%) or wet- (94.4%) vs. uncontrolled-grinding. Task-specific GM of respirable suspended particulate matter (RSP) concentrations (mg/m(3) for LEV:HEPA-, LEV:Shop-vac-, wet-, and uncontrolled grinding, while GV was off/on, were 1.58/0.63, 7.20/1.15, 9.52/4.13, and 152/47.8, respectively. GM concentrations of RSP using 100-125 mm and 180 mm grinding cups were 4.78/1.62 and 22.2/5.06, respectively. GM concentrations of RSP were significantly lower for (1) GV on (70.2%) vs. off, and (2) LEV:HEPA- (98.9%), LEV:Shop-vac- (96.9%) or wet- (92.6%) vs. uncontrolled grinding. Silica dust and RSP were not significantly affected by (1) orientation of grinding surfaces (vertical vs. inclined); (2) water flow rates for wet grinding; (3) length of task-specific sampling time; or, (4) among cup sizes of 100, 115 or 125 mm. No combination of factors or control methods reduced an 8-hr exposure level to below the recommended criterion of 0.025 mg/m(3) for crystalline silica, requiring further refinement in engineering controls, administrative controls, or the use of respirators.

Bang, K. M., et al. (2005). "Tuberculosis mortality by industry in the United States, 1990-1999." Int J Tuberc Lung Dis 9(4): 437-442.

OBJECTIVE: To identify occupations and industries with elevated respiratory tuberculosis (TB) mortality in the United States for the period 1990-1999, we used National Center for Health Statistics multiple-cause-of-death data, restricted to certain states for which information on decedents' usual industry and occupational information was available and limited to US residents aged > or =15 years. DESIGN: A total of 7686 deaths between 1990 and 1999 were attributed to respiratory TB. Proportionate mortality ratios (PMRs), adjusted for age, sex, and race, were calculated from US census occupation and industry classifications.

RESULTS: Industries and occupations involving potential contact with infected cases (e.g., health care workers), those with silica exposure and silicosis (e.g., mining and construction), and those associated with low socioeconomic status had significantly elevated TB mortality. CONCLUSIONS: Overall, the pattern of findings echoes that described in various prior reports, which indicates that the potential for exposure and disease development still persists among certain worker groups. The findings should be useful in guiding occupationally targeted TB prevention programs.

Barlet, G., et al. (2020). "Operating Engineers and the OSHA Silica Standard: A Survey of Union Trainers." New Solut 29(4): 530-535.

Enclosed cabs with filtration systems, an engineering control preferred in the hierarchy of controls, may reduce heavy equipment operators' silica exposure during demolition, grading, and excavation. We surveyed operating engineer trainers about silica training, familiarity with the Occupational Safety and Health Administration (OSHA) silica standard, and cab filtration systems. A voluntary and anonymous online survey was e-mailed to 437 trainers in January 2018. The response rate was 22.9 percent (n = 100). Most trainers (84 percent) covered health risks and silica exposure prevention in their courses. Of these, 59 percent discussed cab filtration as an engineering control. Trainers identified possible barriers to the use of cab filtration systems and a need for education to increase use, and raised concerns about other exposures associated with heavy equipment use. Education about selection, use, and maintenance of cab filtration systems to control silica exposure is needed. Engineering improvements to heavy equipment should address cab filtration, noise, heat, and vibration.

Beamer, B. R., et al. (2005). "Evaluation of misting controls to reduce respirable silica exposure for brick cutting." Ann Occup Hyg 49(6): 503-510.

It is estimated that more than 1.7 million workers in the United States are potentially exposed to respirable crystalline silica, with a large percentage having been exposed to silica concentrations higher than the limits set by current standards and regulations. The purpose of this study is to characterize the use of water-misting engineering controls to reduce exposure to respirable crystalline silica for construction workers engaged in the task of brick cutting. Since data concerning the efficacy of engineering controls collected at worksites is often confounded by factors such as wind, worker skill level, the experiments were conducted in a laboratory environment. A completely enclosed testing chamber housed the brick-cutting saw. Respirable dust concentrations were measured using the Model 3321 Aerodynamic Particle Sizer. Specifically, the laboratory experiment was designed to compare dust suppression through water misting using conventional freely flowing water techniques. Brass atomizing nozzles with three flow rates were used for making this comparison: low (5.0 ml s(-1) or 4.8 gal h(-1)), medium (9.0 ml s(-1) or 8.6 gal h(-1)) and high (18 ml s(-1) or 17.3 gal h(-1)). The flow rate for freely flowing water, using manufacturer-supplied equipment, was 50 ml s(-1) (48 gal h(-1)). The experiment consisted of five replications of five samples each (low-misting, medium-misting, high-misting, freely flowing water and no control). The order of sampling within each replicate was randomized. Estimates of dust reduction showed that low-misting nozzles reduced the respirable mass fraction of dust by about 63%, medium-misting nozzles by about 67%, high-misting nozzles by about 79% and freely flowing water by about 93%. Based on these results, it may be feasible to use misting to control respirable silica dust instead of freely

flowing water. This strategy is of practical interest to the construction industry which must frequently limit the amount of water used on construction sites.

Becker, P., et al. (2001). "Development of an ACGIH construction industry silica exposure database overview." Appl Occup Environ Hyg 16(8): 781-783.
Construction column on building a silica exposure database

Beckett, W. S. and J. Lyons (2007). "Field evaluation of an engineering control for respirable crystalline silica exposures during mortar removal." J Occup Environ Hyg 4(11): D120-121.
(Commentary on Research Article)

Bello, A., et al. (2019). "Characterization of Occupational Exposures to Respirable Silica and Dust in Demolition, Crushing, and Chipping Activities." Ann Work Expo Health 63(1): 34-44.
OBJECTIVES: Exposures to respirable crystalline silica (RCS) and respirable dust (RD) were investigated during demolition, crushing, and chipping at several Massachusetts construction sites. METHODS: Personal breathing zone samples (n = 51) were collected on operating engineers working at demolition and crushing sites, laborers performing miscellaneous tasks at demolition sites, crushing machine tenders at crushing sites, and chipping workers at substructure bridge repair sites. Area samples (n = 33) were collected at the perimeter of demolition and crushing sites to assess potential bystanders' exposures. Exposures 'with' and 'without' the use of dust suppression methods were compared when possible. RD samples were analyzed for crystalline silica content with Fourier Transform Infrared Spectrophotometry (FT-IR) according to the National Institute for Occupational Safety and Health (NIOSH) Method 7602. Statistical analyses of the exposure data were performed in SAS version 9.4. RESULTS: Chipping workers had the highest exposure levels [the geometric mean (GM) time-weighted average (TWA) for RCS was 527 microg/m3 and the GM for RD was 4750 microg/m3]. The next highest exposures were among crushing machine tenders (RCS GM of 93.3 microg/m3 and RD GM of 737.6 microg/m3), while laborers and operating engineers had the lowest exposures (RCS GM of 17.0 and 6.2 microg/m3, respectively). Personal 8-h TWA RCS exposures were higher than the new OSHA permissible exposure limit (PEL) of 50 microg/m3 for 80% of samples collected on chipping workers (n = 31) and 50% of samples collected on crushing machine tenders (n = 8). Operating engineers (n = 9) and laborers (n = 3) had RCS exposures lower than OSHA PEL. The highest concentrations measured would have exceeded the PEL within 15 min chipping and within 2 h of crushing with no further exposure. Chipping workers' RCS exposures were higher than OSHA PEL even when they were adjusted to account for the assigned protection factor of the half-face N95 cartridge respirators used during chipping. Exposures of crushing tenders were reduced to levels under the OSHA PEL when a water spraying system in crushing machines was utilized, but not when a water cannon machine was used. Area samples at demolition and crushing sites indicate overall lower exposures than the PEL, however, bystander workers at crushing sites could be exposed to higher levels compared to demolition sites. Real-time dust monitoring during demolition indicate very high short-term peak exposures. CONCLUSIONS: Controlling or reducing crystalline silica exposures to levels under the new OSHA PEL of 50 microg/m3 remains challenging for chipping workers and crushing machine tenders. Even with the use of dust suppression controls, respiratory protection may be required for various tasks.

Bello, D., et al. (2002). "Quantification of respirable, thoracic, and inhalable quartz exposures by FT-IR in personal impactor samples from construction sites." Appl Occup Environ Hyg 17(8): 580-590.

The classification of quartz as a group I human carcinogen by the International Agency for Research on Cancer (IARC) highlights the need to develop a method to assess quartz exposures in the thoracic and inhalable particle size fractions to supplement the current method for the respirable size fraction. Heavy and highway construction operations can produce high respirable quartz exposures, but inhalable and thoracic exposures have not previously been well characterized. These larger particle size fractions may well contribute to the elevated cancers of the buccal cavity, throat, and GI tract in occupational cohorts of construction workers. A description is provided of the application of FT-IR for quartz analysis of personal cascade impactor air samples collected from highway construction sites. Separate calibration curves were generated for each stage of the four-stage personal impactor by using the impactor to sample quartz dust (Min-U-Sil 5 and Min-U-Sil 30) in an aerosol-generating loop. In addition, three separate calibration curves were generated using filters spiked with bulk Min-U-Sil 5, Min-U-Sil 30, and SRM 1878a (a respirable standard from NIST). The results showed that bulk Min-U-Sil 5 and SRM 1878a calibrations were identical and accurately estimated the respirable quartz fraction. Bulk Min-U-Sil 30 underestimated quartz in stages 1, 2, and 3 by 46 percent, 38 percent, and 18 percent, respectively. Using a respirable standard (bulk Min-U-Sil 5 or SRM 1878a) to quantify the larger particle sizes underestimated quartz in stages 1, 2, and 3 by 73 percent, 72 percent, and 63 percent, respectively. Until a standard reference material for quartz is developed for the larger particle sizes, the method described here, with some modifications, can be used to provide estimates of these biologically relevant particle size fractions. The results of this study also reaffirmed the need to collect narrow ranges of particle size in order to minimize quantification errors, since the FT-IR and XRD instrumental response is particle size-dependent.

Carlo, R. V., et al. (2010). "Laboratory evaluation to reduce respirable crystalline silica dust when cutting concrete roofing tiles using a masonry saw." J Occup Environ Hyg 7(4): 245-251.

Respirable crystalline silica dust exposure in residential roofers is a recognized hazard resulting from cutting concrete roofing tiles. Roofers cutting tiles using masonry saws can be exposed to high concentrations of respirable dust. Silica exposures remain a serious threat for nearly two million U.S. construction workers. Although it is well established that respiratory diseases associated with exposure to silica dust are preventable, they continue to occur and cause disability or death. The effectiveness of both a commercially available local exhaust ventilation (LEV) system and awater suppression system in reducing silica dust was evaluated separately. The LEV system exhausted 0.24, 0.13, or 0.12 m3 /sec of dust laden air, while the water suppression system supplied 0.13, 0.06, 0.03, or 0.02 L/sec of water to the saw blade. Using a randomized block design, implemented under laboratory conditions, the aforementioned conditions were evaluated independently on two types of concrete roofing tiles (s-shape and flat) using the same saw and blade. Each engineering control (LEV or water suppression) was replicated eight times, or four times for each type of tile. Analysis of variance was performed by comparing the mean airborne respirable dust concentrations generated during each run and engineering control treatment. The use of water controls and ventilation controls compared with the “no control” treatment resulted in a statistically significant (p < 0.05) reduction of mean respirable dust concentrations generated per tile cut. The percent reduction

for respirable dust concentrations was 99% for the water control and 91% for the LEV. Results suggest that water is an effective method for reducing crystalline silica exposures. However, water damage potential, surface discolorations, cleanup, slip hazards, and other requirements may make the use of water problematic in many situations. Concerns with implementing an LEV system to control silica dust exposures include sufficient capture velocity, additional weight of the saw with the LEV system, electricity connections, and cost of air handling unit. © 2010 JOEH, LLC.

Carlsten, C., et al. (2007). "Cell markers, cytokines, and immune parameters in cement mason apprentices." Arthritis Rheum 57(1): 147-153.

OBJECTIVE: Cement masons are known to have significant silica exposure, and silica exposure and silicosis are thought to increase risk of autoimmune disease. Because the mechanisms remain obscure, with inconclusive reports of systemic immune effects following silica exposure, our goal was to identify potential early markers of silica-related immunologic and respiratory effects. METHODS: We conducted a cross-sectional study of cement mason apprentices and electrician (control) apprentices. Demographics, dust exposure history, symptoms, spirometry, exhaled nitric oxide, and blood (for immunoglobulins, cytokines, cell counts, and surface markers) were obtained from 11 cement mason apprentices and a comparison group of 21 electrician apprentices. RESULTS: Masons had significantly higher ($P < 0.05$) masonry dust exposure (42 versus 9 dust-hour-years), serum interleukin-1beta (IL-1beta; 12 versus 9 pg/ml), IL-2 (20 versus 8 pg/ml), IL-4 (193 versus 67 pg/ml), IL-10 (44 versus 21 pg/ml), and interferon-gamma (139 versus 65 pg/ml) compared with electricians. In contrast, masons had significantly lower percentages of CD25+ (12% versus 20%) and CD69+ (4% versus 9%) lymphocytes. CONCLUSION: Mason apprentices had higher levels of serum proinflammatory cytokines and lower percentages of CD25+ and CD69+ lymphocytes than did electrician apprentices. These preliminary findings suggest that mason apprentices may be at greater risk of a systemic proinflammatory state that is potentially linked to immune dysregulation. Although distinct limitations of this preliminary data are recognized, this is consistent with early biologic effects leading to increased incidence of autoimmune disease among silica-exposed workers. Prospective studies are needed to validate these initial findings and clarify the temporal sequence of observed relationships.

Carty, P., et al. (2017). "The Effects of Bit Wear on Respirable Silica Dust, Noise and Productivity: A Hammer Drill Bench Study." Ann Work Expo Health.

Objectives: Hammer drills are used extensively in commercial construction for drilling into concrete for tasks including rebar installation for structural upgrades and anchor bolt installation. This drilling task can expose workers to respirable silica dust and noise. The aim of this pilot study was to evaluate the effects of bit wear on respirable silica dust, noise, and drilling productivity. Method: Test bits were worn to three states by drilling consecutive holes to different cumulative drilling depths: 0, 780, and 1560 cm. Each state of bit wear was evaluated by three trials (nine trials total). For each trial, an automated laboratory test bench system drilled 41 holes 1.3 cm diameter, and 10 cm deep into concrete block at a rate of one hole per minute using a commercially available hammer drill and masonry bits. During each trial, dust was continuously captured by two respirable and one inhalable sampling trains and noise was sampled with a noise dosimeter. The room was thoroughly cleaned between trials. Results: When comparing results for the sharp (0 cm) versus dull bit (1560 cm), the mean

respirable silica increased from 0.41 to 0.74 mg m-3 in sampler 1 (P = 0.012) and from 0.41 to 0.89 mg m-3 in sampler 2 (P = 0.024); levels above the NIOSH recommended exposure limit of 0.05 mg m-3. Likewise, mean noise levels increased from 112.8 to 114.4 dBA (P < 0.00001). Drilling productivity declined with increasing wear from 10.16 to 7.76 mm s-1 (P < 0.00001). Discussion: Increasing bit wear was associated with increasing respirable silica dust and noise and reduced drilling productivity. The levels of dust and noise produced by these experimental conditions would require dust capture, hearing protection, and possibly respiratory protection. The findings support the adoption of a bit replacement program by construction contractors.

Cecala, A. B., et al. (2005). "Reducing enclosed cab drill operator's respirable dust exposure with effective filtration and pressurization techniques." J Occup Environ Hyg 2(1): 54-63.

Many different types of surface mining equipment use enclosed cabs to protect equipment operators from health and safety hazards. The overburden removal and mining process can be extremely dusty and can cause excessive dust exposure. To study this issue, a cooperative research effort was established between the National Institute for Occupational Safety and Health, U.S. Silica Co., Clean Air Filter Co., and Red Dot Corp. in an effort to lower respirable dust levels in an enclosed cab on an older surface drill at a silica sand operation. Throughout this research effort, a number of modifications were incorporated into the drill's filtration and pressurization system, as well as in other areas, to improve its design and performance. An average cab efficiency of 93.4% was determined with gravimetric sampling instruments when comparing the outside with the inside cab dust levels on the final design. Although this study considered just one operation, the goal was to identify cost-effective improvements that could be implemented on all types of enclosed cabs to lower respirable dust concentrations. Two critical components for an effective enclosed cab system are having a properly designed, installed, and maintained filtration and pressurization system, along with a method for maintaining structural cab integrity, which allows the cab to be positively pressurized. Another important component is maintaining cab cleanliness. Although this research was originally directed toward the mining industry, it is also applicable to agricultural or construction equipment.

Centers for Disease, C. and Prevention (2005). "Silicosis mortality, prevention, and control--United States, 1968-2002." MMWR Morb Mortal Wkly Rep 54(16): 401-405.

Silicosis is a preventable occupational lung disease caused by inhaling dust containing crystalline silica; no effective treatment for silicosis is available. Deaths from inhalation of silica-containing dust can occur after a few months' exposure (1). Crystalline silica exposure and silicosis have been associated with work in mining, quarrying, tunneling, sandblasting, masonry, foundry work, glass manufacture, ceramic and pottery production, cement and concrete production, and work with certain materials in dental laboratories. To describe patterns of silicosis mortality in the United States, CDC analyzed data from the National Institute for Occupational Safety and Health (NIOSH) National Occupational Respiratory Mortality System (NORMS) for 1968-2002. This report summarizes the results of that analysis, which indicated a decline in silicosis mortality during 1968-2002 and suggested that progress has been made in reducing the incidence of silicosis in the United States. However, silicosis deaths and new cases still occur, even in young workers. Because no effective treatment for silicosis is available, effective control of exposure to crystalline silica in the workplace is crucial.

Centers for Disease, C. and Prevention (2008). "Silicosis-related years of potential life lost before age 65 years--United States, 1968-2005." MMWR Morb Mortal Wkly Rep 57(28): 771-775.

Occupational exposure to respirable crystalline silica occurs in construction, mining, manufacturing, and other industries and can result in silicosis and other lung diseases. Classic (chronic) silicosis results from exposure to relatively low concentrations of respirable crystalline silica for >/=years. Exposure to higher concentrations of silica for 5-10 years can cause accelerated silicosis, and symptoms of acute silicosis can sometimes develop within weeks of initial exposure to extreme concentrations of silica. Deaths in young adults from acute or accelerated silicosis generally reflect more recent and intense exposures. Silicosis is incurable, but preventable through effective control and elimination of exposure to respirable crystalline silica. To characterize recent trends in premature mortality attributed to silicosis in the United States, CDC analyzed annual mortality data from 1968-2005, the most recent years for which complete data were available. Years of potential life lost before age 65 years (YPLL) and mean YPLL were calculated using standard methodology. During 1968-2005, total annual YPLL attributed to silicosis (17,130) declined 90.2%, from 1,441 (mean per decedent: 7.7 YPLL) to 141 (mean per decedent: 11.8), with an annual average of 8.6 YPLL per decedent for the period. However, the proportion of YPLL attributable to young silicosis decedents increased; an estimated 3,600-7,300 new silicosis cases occur annually. Hazard surveillance, workplace-specific interventions, and further silicosis prevention and elimination efforts, especially among young adults, are needed.

Collingwood, S. and W. A. Heitbrink (2007). "Field evaluation of an engineering control for respirable crystalline silica exposures during mortar removal." J Occup Environ Hyg 4(11): 875-887.

During mortar removal with a right angle grinder, a building renovation process known as "tuck pointing," worker exposures to respirable crystalline silica can be as high as 5 mg/m(3), 100 times the recommended exposure limit developed by the National Institute for Occupational Safety and Health. To reduce the risk of silicosis among these workers, a vacuum cleaner can be used to exhaust 80 ft(3)/min (2.26 m(3)/min) from a hood mounted on the grinder. Field trials examined the ability of vacuum cleaners to maintain adequate exhaust ventilation rates and measure exposure outcomes when using this engineering control. These field trials involved task-based exposure measurement of respirable dust and crystalline silica exposures during mortar removal. These measurements were compared with published exposure data. Vacuum cleaner airflows were obtained by measuring and digitally logging vacuum cleaner static pressure at the inlet to the vacuum cleaner motor. Static pressures were converted to airflows based on experimentally determined fan curves. In two cases, video exposure monitoring was conducted to study the relationship between worker activities and dust exposure. Worker activities were video taped concurrent with aerosol photometer measurement of dust exposure and vacuum cleaner static pressure as a measure of airflow. During these field trials, respirable crystalline silica exposures for 22 samples had a geometric mean of 0.06 mg/m(3) and a range of less than 0.01 to 0.86 mg/m(3). For three other studies, respirable crystalline silica exposures during mortar removal have a geometric means of 1.1 to 0.35. Although this field study documented noticeably less exposure to crystalline silica, video exposure monitoring found that the local exhaust ventilation provided incomplete dust control due to low exhaust flow rates, certain work practices, and missing mortar. Vacuum cleaner

airflow decrease had a range of 3 to 0.4 ft(3)/min (0.08 to 0.01 m(3)/sec(2)) over a range of vacuum cleaners, hose diameters, and hose lengths. To control worker exposure to respirable crystalline silica, local exhaust ventilation needs to be incorporated into a comprehensive silica control program that includes respiratory protection, worker training, and local exhaust ventilation.

Cooper, M. R., et al. (2012). "Evaluation and control of respirable silica exposure during lateral drilling of concrete." J Occup Environ Hyg 9(2): D35-41.

(Case study using universal drill rig)

Cothern, E. J., et al. (2023). "The Evaluation of Worker Exposure to Airborne Silica Dust During Five OSHA Table I Construction Tasks." Ann Work Expo Health.

Fifty-one (51) personal silica air samples were collected over 13 days on 19 construction employees while they performed five different construction tasks found in the Occupational Safety and Health Administration's (OSHA) respirable crystalline silica standard for construction, Table 1, which specifies engineering, work practice, and respiratory protection controls that employers can use in lieu of exposure monitoring to adhere to the standard. The average construction task time was 127 min (range: 18-240 min) with a mean respirable silica concentration of 85 mug m-3 (standard deviation [SD] = 176.2) for all 51 measured exposures. At least one OSHA-specified silica dust control measure was used during all 51 samples collected. The mean silica concentrations for the five tasks were: core drilling 11.2 mug m-3 (SD = 5.31 mug m-3), cutting with a walk-behind saw 126 mug m-3 (SD = 115 mug m-3), dowel drilling 99.9 mug m-3 (SD = 58.7 mug m-3), grinding 172 mug m-3 (SD = 145 mug m-3), and jackhammering 23.2 mug m-3 (SD = 5.19 mug m-3). Twenty four of 51 (47.1%) workers were exposed above the OSHA Action Level (AL) of 25 mug m-3 and 15 of 51 (29.4%) were exposed above the OSHA Permissible Exposure Limit (PEL) of 50 mug m-3 when exposures were extrapolated to an 8-h shift. When silica exposures were extrapolated to 4 h, 15 of 51 (29.4%) of workers sampled were exposed over the OSHA AL and 8 of 51 (15.7%) were exposed over the OSHA PEL. A total of 15 area airborne respirable crystalline silica samples were collected on days where the personal task-based silica samples were taken, with an average sampling time of 187 min. Of the 15 area respirable crystalline silica samples, only four were greater than the laboratory reporting limit of 5 mug m-3. The four area silica samples with reportable concentrations revealed background silica concentrations of 23 mug m-3, 5 mug m-3, 40 mug m-3, and 100 mug m-3. Odds ratios were used to analyze the apparent association between dichotomous background construction site exposures to respirable crystalline silica (detectable or not detectable), and personal exposure category (over or not over the OSHA AL and PEL) when exposure times were extrapolated to 8 h. The associations were strongly positive and significant between detectable background exposures and personal overexposures for workers conducting the five Table 1 tasks with engineering controls in place. The results of this study suggest that exposure to hazardous levels of respirable crystalline silica may be present even when OSHA-specified engineering controls are implemented. The current study findings also suggest that background construction site silica concentrations may potentially cause task-based overexposures, even when the OSHA Table 1 control methods have been put in place.

Croteau, G. A., et al. (2004). "The efficacy of local exhaust ventilation for controlling dust exposures during concrete surface grinding." Ann Occup Hyg 48(6): 509-518.

This study assessed the effectiveness of a commercially available local exhaust ventilation (LEV) system for controlling respirable dust and crystalline silica exposures during concrete grinding activities. Surface grinding was conducted at six commercial building construction sites in Seattle, WA, by cement masons. Time-integrated filter samples and direct reading respirable dust concentrations were collected using a cyclone in line with a direct reading respirable dust monitor. Personal exposure levels were determined with and without LEV, one sample directly after the other. A total of 28 paired samples were collected in which three different dust collection shroud configurations were tested. Data obtained with a direct reading respirable dust monitor were adjusted to remove non-work task-associated dust exposures and was subsequently used to calculate the exposure reduction achieved. The application of LEV resulted in a reduction in the overall geometric mean respirable dust exposure from 4.5 to 0.14 mg/m(3), a mean exposure reduction of 92%. Despite the effective control of dust generated during surface grinding, 22 and 26% of the samples collected while LEV was being used were greater than the 8 h time-weighted average permissible exposure limit (Occupational Safety and Health Administration) and threshold limit value (American Congress of Governmental Industrial Hygienists) for respirable crystalline silica, respectively.

Croteau, G. A., et al. (2002). "The effect of local exhaust ventilation controls on dust exposures during concrete cutting and grinding activities." Am Ind Hyg Assoc J 63(4): 458-467.

This study assessed the effectiveness of commercially available local exhaust ventilation (LEV) systems for controlling respirable dust and crystalline silica exposures during concrete cutting and grinding activities. Work activities were performed by union-sponsored apprentices and included tuck-point grinding, surface grinding, paver block and brick cutting (masonry saw), and concrete block cutting (hand-held saw). In a randomized block design, implemented under controlled field conditions, three ventilation rates (0, 30, and 75 cfm) were tested for each tool. Each ventilation treatment was replicated three times in random order for a total of nine 15-min work sessions per study subject. With the exception of the hand-held saw, the use of LEV resulted in a significant ($p < 0.05$) reduction in respirable dust exposure. Mean exposure levels for the 75 cfm treatments were less than that of the 30 cfm treatments; however, differences between these two treatments were only significant for paver block cutting ($p < 0.01$). Although exposure reduction was significant (70-90% at the low ventilation rate and 80-95% reduction at the high ventilation rate), personal respirable quartz exposures remained very high: 1.4-2.8 × PEL (permissible exposure limit) at the low ventilation rate and 0.9-1.7 × PEL at the high ventilation rate. Exposure levels found under actual field conditions would likely be lower due to the intermittent nature of most job tasks. Despite incomplete control, LEV has merit, as it would reduce the risk of workers developing disease, allow workers to use a lower level of respiratory protection, protect workers during short duration work episodes, reduce exposure to nearby workers, and reduce clean-up associated dust exposures.

Delp, L., et al. (2013). "Shaping the future: ten years of the occupational health internship program." New Solut 23(2): 253-281.

The Occupational Health Internship Program (OHIP) was initiated in 2003 to recruit a new, diverse generation of occupational safety and health (OSH) professionals and to advance OSH within union and community-based initiatives. It retains the principles of the original

OCAW/Montefiore internship program while adapting to the changed landscape of the 21st-century workplace. Case studies of OHIP projects illustrate how students have contributed to key OSH policies-to regulate silica exposure among construction workers, apply principles of green chemistry with Vietnamese nail salon workers, and integrate OSH into "green" jobs in the recycling industry. They have supported innovative campaigns with immigrant workers in contingent jobs-from taxi drivers to warehouse workers. The students, in turn, have been inspired to enter the OSH arena as professionals and worker advocates with the potential to contribute new energy to an OSH movement.

Dement, J. M., et al. (2020). "Lung cancer mortality among construction workers: implications for early detection." Occup Environ Med 77(4): 207-213.

OBJECTIVES: This study examined predictors of lung cancer mortality, beyond age and smoking, among construction workers employed at US Department of Energy (DOE) sites to better define eligibility for low-dose CT (LDCT) lung cancer screening. METHODS: Predictive models were based on 17 069 workers and 352 lung cancer deaths. Risk factors included age, gender, race/ethnicity, cigarette smoking, years of trade or DOE work, body mass index (BMI), chest X-ray results, spirometry results, respiratory symptoms, beryllium sensitisation and personal history of cancer. Competing risk Cox models were used to obtain HRs and to predict 5-year risks. RESULTS: Factors beyond age and smoking included in the final predictive model were chest X-ray changes, abnormal lung function, chronic obstructive pulmonary disease (COPD), respiratory symptoms, BMI, personal history of cancer and having worked 5 or more years at a DOE site or in construction. Risk-based LDCT eligibility demonstrated improved sensitivity, specificity and positive predictive value compared with current US Preventive Services Task Force guidelines. The risk of lung cancer death from 5 years of work in the construction industry or at a DOE site was comparable with the risk from a personal cancer history, a family history of cancer or a diagnosis of COPD. LDCT eligibility criteria used for DOE construction workers, which includes factors beyond age and smoking, identified 86% of participants who eventually would die from lung cancer compared with 51% based on age and smoking alone. CONCLUSIONS: Results support inclusion of risk from occupational exposures and non-malignant respiratory clinical findings in LDCT clinical guidelines.

Dement, J. M., et al. (2003). "Surveillance of respiratory diseases among construction and trade workers at Department of Energy nuclear sites." Am J Ind Med 43(6): 559-573.

BACKGROUND: Medical screening programs were begun in 1996 and 1997 at three Department of Energy (DOE) nuclear weapons facilities (Hanford Nuclear Reservation, Oak Ridge, and the Savannah River Site) to evaluate whether current and former construction workers are at significant risk for occupational illnesses. The focus of this report is pneumoconiosis associated with exposures to asbestos and silica among workers enrolled in the screening programs through September 30, 2001. METHODS: Workers provided a detailed work and exposure history and underwent a respiratory examination, which included a respiratory history and symptom questionnaire, a posterior-anterior (P-A) chest radiograph, and spirometry. Both stratified and multivariate logistic regression analyses were used to explore the risk of disease by duration of DOE employment and frequency of exposure, while controlling for potential confounders such as age, race, sex, and other work in the construction and building trades. RESULTS: Of the 2602 workers, 25.2% showed one or more chest X-ray

changes by ILO criteria and 42.7% demonstrated one or more pulmonary function defects. The overall prevalence of parenchymal changes by ILO criteria (profusion 1/0 or greater) was 5.4%. In the logistic regression models, the odds ratio for parenchymal disease was 2.6 (95% confidence interval (CI) = 1.0-6.6) for workers employed 6 to 20 years at Hanford or Savannah River and increased to 3.6 (95% CI = 1.1-11.6) for workers employed more than 35 years, with additional incremental risks for workers reporting routine exposures to asbestos or silica. CONCLUSIONS: Continued surveillance of workers is important given their increased risk of disease progression and their risk for asbestos related malignancies. Smoking cessation programs should also be high priority and continued abstinence for former smokers reinforced. Although the observed respiratory disease patterns are largely reflective of past exposures, these findings suggest that DOE needs to continue to review industrial hygiene control programs for work tasks involving maintenance, repair, renovation, and demolition.

Dement, J. M., et al. (2010). "Airways obstruction among older construction and trade workers at Department of Energy nuclear sites." Am J Ind Med 53(3): 224-240.

BACKGROUND: A study of chronic obstructive pulmonary disease (COPD) among 7,579 current and former workers participating in medical screening programs at Department of Energy (DOE) nuclear weapons facilities through September 2008 was undertaken. METHODS: Participants provided a detailed work and exposure history and underwent a respiratory examination that included a respiratory history, respiratory symptoms, a posterior-anterior (P-A) chest radiograph classified by International Labour Office (ILO) criteria, and spirometry. Statistical models were developed to generate group-level exposure estimates that were used in multivariate logistic regression analyses to explore the risk of COPD in relation to exposures to asbestos, silica, cement dust, welding, paints, solvents, and dusts/fumes from paint removal. Risk for COPD in the study population was compared to risk for COPD in the general US population as determined in National Health and Nutrition Examination Survey (NHANES III). RESULTS: The age-standardized prevalence ratio of COPD among DOE workers compared to all NHANES III data was 1.3. Internal analyses found the odds ratio of COPD to range from 1.6 to 3.1 by trade after adjustment for age, race, sex, smoking, and duration of DOE employment. Statistically significant associations were observed for COPD and exposures to asbestos, silica, welding, cement dusts, and some tasks associated with exposures to paints, solvents, and removal of paints. CONCLUSIONS: Our study of construction workers employed at DOE sites demonstrated increased COPD risk due to occupational exposures and was able to identify specific exposures increasing risk. This study provides additional support for prevention of both smoking and occupational exposures to reduce the burden of COPD among construction workers.

Doney, B. C., et al. (2020). "Estimation of the number of workers exposed to respirable crystalline silica by industry: Analysis of OSHA compliance data (1979-2015)." Am J Ind Med 63(6): 465-477.

BACKGROUND: Respirable crystalline silica (RCS) can potentially cause silicosis, lung cancer, and renal failure. The current study estimates the percentages of workers potentially overexposed to concentrations of RCS dust and silicosis proportional mortality rates (PMRs) by industry. METHODS: Occupational Safety and Health Administration compliance inspection sampling data for RCS collected during 1979 to 2015 were used to estimate percentages of workers exposed. The results were used in combination with US Census Bureau

estimates to produce industry specific worker population estimates for 2014. Estimates of the numbers and percentages of workers exposed to RCS concentrations at least 1, 2, 5, and 10 times the National Institute for Occupational Safety and Health recommended exposure limit (REL) were calculated by industry using the 2002 North American Industry Classification System. Silicosis PMRs by industry were estimated using National Center for Health Statistics multiple cause of death data. RESULTS: RCS concentrations/workers exposed were highest in the poured concrete foundation and structure contractors; commercial and institutional building construction; and masonry contractors. Approximately 100 000 workers were exposed above the RCS REL, and most (79%) worked in the construction industry. Tile and terrazzo contractors (12%); brick, stone, and related construction merchant wholesalers (10%); masonry contractors (6%) and poured concrete foundation and structure contractors (6%) were the highest percentages of workers potentially overexposed. PMRs were highest for the structural clay product manufacturing and the foundries industries. CONCLUSION: Percentages of workers exposed to RCS varied by industry and in some industries workers are exposed over 10 times the REL. Exposures can be reduced below the REL by implementing the hierarchy of controls.

Epling, C., et al. (1999). "Airborne Exposures and Ambulatory Peak Expiratory Flow in Drywall Finishers (CPWR Report) ".

Flanagan, M. E., et al. (2006). "Silica exposure on construction sites: results of an exposure monitoring data compilation project." J Occup Environ Hyg 3(3): 144-152.

To expand on the limited size and scope of construction silica exposure studies, a silica monitoring data compilation project was initiated through the American Conference of Governmental Industrial Hygienists Construction Committee. Personal silica exposure monitoring data was collected and analyzed from 13 private, research, and regulatory groups. An effort was made to collect as much detail as possible about task, tool, and environmental and control conditions so as much information as possible could be garnered. There were considerable data gaps, particularly with regulatory agency data, that represented over half of the data set. There were 1374 personal quartz samples reported with a geometric mean of 0.13 mg/m(3) and a GSD of 5.9. Descriptive statistics are reported by trade, task, tool, and data source type. Highest exposures were for abrasive blasters, surface and tuckpoint grinders, jackhammers, and rock drills. The sample period was important, with short-term samples (up to 2 hours) having considerably higher levels than midterm (2-6 hours) or longer (over 6 hours) samples. For nearly all exposure variables, a large portion of variable categories were at or over the quartz occupational exposure limit of 0.05 mg/m(3), including 8 of 8 trade, 13 of 16 task, and 12 of 16 tool categories. The respiratory protection commonly used on construction sites is often inadequate for the exposures encountered. The data variability within task and tool was very large, with some very high exposures reported for a broad spectrum of tools. Further understanding of the conditions leading to high exposures will require more detailed documentation of the sample characteristics following database design recommendations or systematic surveys of exposure in this complex industry.

Flynn, M. R. and P. Susi (2003). "Engineering controls for selected silica and dust exposures in the construction industry--a review." Appl Occup Environ Hyg 18(4): 268-277.

This literature review summarizes engineering control technology research for dust and silica exposures associated with selected tasks in the construction industry. Exposure to crystalline silica can cause silicosis and lung fibrosis, and evidence now links it with lung cancer. Of over 30 references identified and reviewed, 16 were particularly significant in providing data and analyses capable of documenting the efficacy of various engineering controls. These reports include information on generation rates and worker exposures to silica and dust during four different tasks: cutting brick and concrete block, grinding mortar from between bricks, drilling, and grinding concrete surfaces. The major controls are wet methods and local exhaust ventilation. The studies suggest that while the methods provide substantial exposure reductions, they may not reduce levels below the current ACGIH threshold limit value (TLV) of 0.05 mg/m(3) for respirable quartz. Although further research on controls for these operations is indicated, it is clear that effective methods exist for significant exposure reduction.

Flynn, M. R. and P. Susi (2004). "A review of engineering control technology for exposures generated during abrasive blasting operations." J Occup Environ Hyg 1(10): 680-687.

This literature review presents information on measures for controlling worker exposure to toxic airborne contaminants generated during abrasive blasting operations occurring primarily in the construction industry. The exposures of concern include respirable crystalline silica, lead, chromates, and other toxic metals. Unfortunately, silica sand continues to be widely used in the United States as an abrasive blasting medium, resulting in high exposures to operators and surrounding personnel. Recently, several alternative abrasives have emerged as potential substitutes for sand, but they seem to be underused Some of these abrasives may pose additional metal exposure hazards. In addition, several new and improved technologies offer promise for reducing or eliminating exposures; these include wet abrasive blasting, high-pressure water jetting, vacuum blasting, and automated/robotic systems. More research, particularly field studies, is needed to evaluate control interventions in this important and hazardous operation.

Garcia, A., et al. (2014). "An evaluation of an aftermarket local exhaust ventilation device for suppressing respirable dust and respirable crystalline silica dust from powered saws." J Occup Environ Hyg 11(11): D200-D207.

The objective of this study was to quantify the respirable dust and respirable silica exposures of roofing workers using an electric-powered circular saw with an aftermarket local exhaust ventilation attachment to cut concrete roofing tiles. The study was conducted to determine whether the local exhaust ventilation attachment was able to control respirable dust and respirable silica exposure below occupational exposure limits (OELs). Time-integrated filter samples and direct reading respirable dust concentrations were evaluated. The local exhaust ventilation consisted of a shroud attached to the cutting plane of the saw; the shroud was then connected to a small electric axial fan, which is intended to collect dust at the point of generation. All sampling was conducted with the control in use. Roofers are defined as those individuals who only lay tiles. Cutters/roofers are defined as those workers who operate the powered saw to cut tiles and also lay tiles. Respirable dust from this evaluation ranged from 0.13 to 6.59 milligrams per cubic meter (mg/m3) with a geometric mean of 0.38 mg/m3 for roofers and from 0.45 to 3.82 mg/m3 with a geometric mean of 1.84 mg/m3 for cutters/roofers. Cutters/roofers usually handle areas close to crevices, edges, or tips of the roof whereas roofers handle areas where complete tiles can be placed. The respirable dust exposures for all

cutters/roofers indicated concentrations exceeding the Occupational Safety and Health Administration's (OSHA) permissible exposure limit (PEL) for respirable dust containing silica; it was also exceeded for some of the roofers. The respirable silica concentrations ranged from 0.04 to 0.15 mg/m3 with a geometric mean of 0.09 mg/m3 for roofers, and from 0.13 to 1.21 mg/m3 with a geometric mean of 0.48 mg/m3 for cutters/roofers. As with respirable dust, the respirable silica exposures for cutters/roofers were higher than the exposures for roofers. © 2014 JOEH, LLC.

Ghahramani, N. (2010). "Silica nephropathy." Int J Occup Environ Med 1(3): 108-115.

Occupational exposure to heavy metals, organic solvents and silica is associated with a variety of renal manifestations. Improved understanding of occupational renal disease provides insight into environmental renal disease, improving knowledge of disease pathogenesis. Silica (SiO2) is an abundant mineral found in sand, rock, and soil. Workers exposed to silica include sandblasters, miners, quarry workers, masons, ceramic workers and glass manufacturers. New cases of silicosis per year have been estimated in the US to be 3600-7300. Exposure to silica has been associated with tubulointerstitial disease, immune-mediated multisystem disease, chronic kidney disease and end-stage renal disease. A rare syndrome of painful, nodular skin lesions has been described in dialysis patients with excessive levels of silicon. Balkan endemic nephropathy is postulated to be due to chronic intoxication with drinking water polluted by silicates released during soil erosion. The mechanism of silica nephrotoxicity is thought to be through direct nephrotoxicity, as well as silica-induced autoimmune diseases such as scleroderma and systemic lupus erythematosus. The renal histopathology varies from focal to crescentic and necrotizing glomerulonephritis with aneurysm formation suggestive of polyarteritis nodosa. The treatment for silica nephrotoxicity is non-specific and depends on the mechanism and stage of the disease. It is quite clear that further research is needed, particularly to elucidate the pathogenesis of silica nephropathy. Considering the importance of diagnosing exposure-related renal disease at early stages, it is imperative to obtain a thorough occupational history in all patients with renal disease, with particular emphasis on exposure to silica, heavy metals, and solvents.

Gharpure, A., et al. (2021). "Characterization and Hazard Identification of Respirable Cement and Concrete Dust from Construction Activities." Int J Environ Res Public Health 18(19).

Construction is an important segment of the economy that employs millions of people. Construction dust is an occupational health hazard to millions of construction workers worldwide. The hazards associated with respirable dust depend upon its particulate size distribution and chemical composition, as these determine the deposition pattern in the respiratory tract and reactivity, respectively. This study presents characterization of the size and composition of the dust from two key construction materials-cast cement and poured concrete. The dust was generated by cutting the cured cement and concrete blocks using an 18" hand-held circular saw as used in highway and building construction. Transmission electron microscopy, scanning electron microscopy, dynamic light scattering, and laser diffraction were performed for the size analysis of the particles. Energy dispersive spectroscopy and X-ray photoelectron spectroscopy were used for chemical analysis. X-ray diffraction was used for phase identification. Electron diffraction patterns were obtained to assess the crystallinity of individual particles. They confirm the crystallinity of particles of different size and shapes. With a particle size range between 0.5 mum and 10 mum, greater than 90% of particles fell below 2.5

mum, presenting a respirable health concern. Crystalline compounds including the metals Al, Ca, Fe, Mg, Na, and K were detected. The concrete particles were most enriched in crystalline silica with a concentration of more than 30% by weight. The presence of metals and high crystalline silica content pose a serious health concern to construction workers.

Golla, V. and W. Heitbrink (2004). "Control technology for crystalline silica exposures in construction: wet abrasive blasting." J Occup Environ Hyg 1(3): D26-32.

This study was designed to document the effect that wet abrasive blasting has on reducing worker exposure to crystalline silica, which has been associated with silicosis and premature death. In this study, worker exposure to respirable crystalline silica was monitored during wet abrasive blasting on the exterior walls of a parking garage to remove surface concrete and expose the underlying aggregate. In this process a wet sand mix comprised of 80% dry sand and 20% water was used. Sampling and analysis revealed that the geometric mean respirable quartz concentration was 0.2 mg/m(3) for workers conducting abrasive blasting and 0.06 mg/m(3) for helpers. When abrasive blasting was conducted in areas that apparently had reduced natural ventilation, dust exposures appeared to increase. When compared with other published data, this case study suggests that wet abrasive blasting causes less exposure to crystalline silica than dry abrasive blasting.

Hall, R. M., et al. (2013). "Exposure assessment for roofers exposed to silica during installation of roof tiles." J Occup Environ Hyg 10(1): D6-10.

Occupational exposure to silica in the construction industry has been well documented, and respirable crystalline silica has been associated with silicosis, lung cancer, pulmonary tuberculosis, and airway diseases. These concerns prompted a local construction union to request assistance from the National Institute for Occupational Safety and Health (NIOSH) for health hazard evaluations concerning exposures to dust and silica among roofers in Phoenix, Arizona. In response to these requests, NIOSH performed field studies to evaluate roofers' exposures to silica.

Hammond, D. R., et al. (2016). "Respirable crystalline silica exposures during asphalt pavement milling at eleven highway construction sites." J Occup Environ Hyg 13(7): 538-548.

Asphalt pavement milling machines use a rotating cutter drum to remove the deteriorated road surface for recycling. The removal of the road surface has the potential to release respirable crystalline silica, to which workers can be exposed. This article describes an evaluation of respirable crystalline silica exposures to the operator and ground worker from two different half-lane and larger asphalt pavement milling machines that had ventilation dust controls and water-sprays designed and installed by the manufacturers. Manufacturer A completed milling for 11 days at 4 highway construction sites in Wisconsin, and Manufacturer B completed milling for 10 days at 7 highway construction sites in Indiana. To evaluate the dust controls, full-shift personal breathing zone air samples were collected from an operator and ground worker during the course of normal employee work activities of asphalt pavement milling at 11 different sites. Forty-two personal breathing zone air samples were collected over 21 days (sampling on an operator and ground worker each day). All samples were below 50 microg/m(3) for respirable crystalline silica, the National Institute for Occupational Safety and Health recommended exposure limit. The geometric mean personal breathing zone air sample was 6.2 microg/m(3) for the operator and 6.1 microg/m(3) for the ground worker for the

Manufacturer A milling machine. The geometric mean personal breathing zone air sample was 4.2 microg/m(3) for the operator and 9.0 microg/m(3) for the ground worker for the Manufacturer B milling machine. In addition, upper 95% confidence limits for the mean exposure for each occupation were well below 50 microg/m(3) for both studies. The silica content in the bulk asphalt material being milled ranged from 7-23% silica for roads milled by Manufacturer A and from 5-12% silica for roads milled by Manufacturer B. The results indicate that engineering controls consisting of ventilation controls in combination with water-sprays are capable of controlling occupational exposures to respirable crystalline silica generated by asphalt pavement milling machines on highway construction sites.

Heitbrink, W. (2005). "Protecting Tuckpointing Workers from Silica Dust: Draft Recommendations for a Ventilated Grinder (CPWR Report) ".

Heitbrink, W. (2007). "Field Tests of a Water Induction Nozzle as a Dust Control for Abrasive Blasting (CPWR Report) ".

Heitbrink, W. and J. Bennett (2006). "A numerical and experimental investigation of crystalline silica exposure control during tuck pointing." J Occup Environ Hyg 3(7): 366-378.

National Institute for Occupational Safety and Health researchers investigated control measures for the removal of mortar between bricks, using a grinder. This task, "tuck pointing," is associated with crystalline silica exposures many times greater than the permissible exposure limit enforced by the Occupational Safety and Health Administration. Previous studies showed that local exhaust ventilation (LEV) of the grinding wheel through a shroud was often ineffective. Tuck pointing occurs on a scaffold. For practical purposes, this limits the size and power of the LEV system. Thus, the goal of this study was to develop a recommended flow rate for exposure control. Flow induced by the rotating grinding wheel, flow induced by the mortar particle stream, and particle momentum are potential control challenges. Computational fluid dynamic (CFD) simulation of the grinder, supported by some experimental measurements, showed the relative importance of these factors through varying parameters and tracking particles. In a simulation of the shroud and grinding wheel, with the wheel inserted to a cutting depth of 0.750 inch flush into the brick wall, -0.461 cubic feet per meter (0.461 into the exhaust takeoff) was induced by the rotating wheel. The more realistic situation of the wheel in a cut in the wall 1.25 inches deep (forming a trench circumferentially 0.500 inch below the wheel edge) induced an airflow of 8.24 cfm out of the shroud exhaust. Experimental measurements taken for validation were 7.3% lower than the CFD value. The trench effect disappeared when a stream of 10-mu m particles was launched from the grinding wheel edge, as the simulations with and without the trench had nearly identical induced flow rates, 10.8 cfm and 10.9 cfm. We thus interpreted the particle stream as more important than the wheel in inducing flow. This insight was possible because of the power of CFD, compared to intuition and classical boundary layer analysis. In this situation of no forced exhaust, all particles escaped through the gap between the shroud edge and the brick wall into the worker's environment. Experiments and simulations indicated that approximately 85 cfm was required for good control of silica exposure, clearly demonstrating that the exhaust rate must accomplish much more than balancing the induced flow. The simulations showed that the exhaust must create a vacuum in the shroud sufficient to bend the particle paths into the shroud. In the simulations, stopping the particle stream through collision (effectively removing or reducing the "daylight" between the wall and shroud) greatly

lessened the required flow rate. This is difficult in practice because the gaps between the shroud and the brick and between bricks create escape paths.

Heitbrink, W. and J. S. Elias (2008). "The Effect of Debris Accumulation Upon Air Flow and Filter Resistance to Air Flow for Four Commercially Available Vacuum Cleaners (CPWR Report)."

Heitbrink, W. A. and J. Santalla-Elias (2009). "The effect of debris accumulation on and filter resistance to airflow for four commercially available vacuum cleaners." J Occup Environ Hyg 6(6): 374-384.

Mortar removal with right-angle grinders can cause excessive exposure to respirable crystalline silica. To control this dust exposure, vacuum cleaners need to exhaust 2.3 m(3)/min (80 cubic feet per minute) from the grinder's exhaust hood. Maintaining this airflow while collecting as much as 15.9 kg (35 lb) of debris in the vacuum cleaner has been problematic. A laboratory study was conducted to evaluate how mortar debris affects vacuum cleaner airflow and filter pressure loss. Four vacuum cleaners were tested. Two of the vacuum cleaners used vacuum cleaner bags as a prefilter; the other two vacuum cleaners used cyclones to reduce the amount of debris that reaches the filter. Test debris was collected by a masonry restoration contractor during actual mortar removal using a grinder fitted with a hood. The hood is attached to a vacuum cleaner with cyclonic pre-separation. The vacuum cleaner fan curves were obtained experimentally to learn how pressure loss affects vacuum cleaner airflows. Then, 15.9 kg (35 lb) of mortar removal debris was sucked into the vacuum cleaner in 2.27-kg (5-lb) increments. Before and after adding each 2.27-kg (5-lb) increment of debris, vacuum cleaner airflows were measured with a venturi meter, and vacuum cleaner static pressures were measured at the inlet to the vacuum cleaner motor, and before and after each filter. The vacuum cleaners equipped with cyclonic pre-separation were unaffected by the mass of debris collected in the vacuum cleaner and were able to maintain airflows in excess of 1.98 m(3)/min (70 cfm) throughout the testing program. As debris accumulated in the vacuum cleaners that used bags, airflow decreased from 2.3 m(3)/min (80 cfm) to as little as 0.85 m(3)/min (30 cfm). This airflow loss is caused by the increased airflow resistance of the bags that increased from less 0.03 kPa/m(3)/min (0.1 inches of water per cfm) to 16.7 kPa/m(3)/min (1.9 inches of water/cfm). Apparently, vacuum cleaners using bags should be used in applications where adequate dust control can be achieved at airflows less than 0.85 m(3)/min (30 cfm). Vacuum cleaners with cyclonic pre-separators provided superior and cost-effective dust control compared with vacuums with bags when dust loading was high and when more than 30 cfm of airflow is needed for dust control.

Hong, O., et al. (2014). "The association between occupational exposures and cigarette smoking among operating engineers." Archives of Environmental and Occupational Health 69(3): 172-179.

The purpose of this study was to determine the relationship between occupational exposures and cigarette smoking among operating engineers. A cross-sectional survey was conducted with operating engineers (N =412) from a midwestern state in the United States. The survey included validated questions on cigarette smoking, occupational exposures, demographics, comorbidities, and health behaviors. About 35% were current smokers. Those exposed to asphalt fumes, heat stress, concrete dust, and welding fumes were less likely to

smoke (odds ratio [OR] = .79, 95% confidence interval [CI]: .64-.98). Other factors associated with smoking included younger age (OR = .97, 95% CI: .94-.99), problem drinking (OR = 1.07, 95% CI: 1.03-1.12), lower Body Mass Index (OR = .95, 95% CI: .90-.99), and being separated/widowed/divorced (OR = 2.24, 95% CI: 1.19-4.20). Further investigation is needed for better understanding about job-specific exposure patterns and their impact on cigarette smoking among operating engineers. © 2014 Taylor & Francis Group, LLC.

Hua, J. T., et al. (2023). "Pathology and Mineralogy of the Pneumoconioses." Semin Respir Crit Care Med 44(3): 327-339.

Pneumoconioses represent the spectrum of lung diseases caused by inhalation of respirable particulate matter small enough (typically <5-microm diameter) to reach the terminal airways and alveoli. Pneumoconioses primarily occur in occupational settings where workers perform demanding and skilled manual labor including mining, construction, stone fabrication, farming, plumbing, electronics manufacturing, shipyards, and more. Most pneumoconioses develop after decades of exposure, though shorter latencies can occur from more intense particulate matter exposures. In this review, we summarize the industrial exposures, pathologic findings, and mineralogic features of various well-characterized pneumoconioses including silicosis, silicatosis, mixed-dust pneumoconiosis, coal workers' pneumoconiosis, asbestosis, chronic beryllium disease, aluminosis, hard metal pneumoconiosis, and some less severe pneumoconioses. We also review a general framework for the diagnostic work-up of pneumoconioses for pulmonologists including obtaining a detailed occupational and environmental exposure history. Many pneumoconioses are irreversible and develop due to excessive cumulative respirable dust inhalation. Accurate diagnosis permits interventions to minimize ongoing fibrogenic dust exposure. A consistent occupational exposure history coupled with typical chest imaging findings is usually sufficient to make a clinical diagnosis without the need for tissue sampling. Lung biopsy may be required when exposure history, imaging, and testing are inconsistent, there are unusual or new exposures, or there is a need to obtain tissue for another indication such as suspected malignancy. Close collaboration and information-sharing with the pathologist prior to biopsy is of great importance for diagnosis, as many occupational lung diseases are missed due to insufficient communication. The pathologist has a broad range of analytic techniques including bright-field microscopy, polarized light microscopy, and special histologic stains that may confirm the diagnosis. Advanced techniques for particle characterization such as scanning electron microscopy/energy dispersive spectroscopy may be available in some centers.

Hubbard, B. J. and B. Middaugh (2013). "Leveraging Bluetooth Consumer Electronics as Proximity Sensors to Construction Health Hazards." International Journal of Construction Education and Research 9(2): 117-131.

There are numerous hazards on construction sites. Significant research has focused on using advanced technologies to prevent collisions between moving construction equipment and workers. Relatively few studies have focused on advanced technologies to quantify worker exposure to long-term health hazards, such as noise, fumes, silica dust and other exposure hazards. One possible technology is wireless Bluetooth systems to quantify exposure risk. A series of tests was designed to investigate leveraging consumer Bluetooth enabled devices as a platform to determine the proximity of a construction worker to potential construction hazards. Bluetooth enabled devices were tested in controlled studies to determine the characteristics of

the signal detection and signal strength. The controlled studies demonstrated the viability of estimating the distance between a Bluetooth receiver and emitting device. In a field test, the receiver system performed reasonably well and the system was able to determine when workers were within approximately 50 to 100 feet of the construction hazard. However, signal disruption between the emitter and the receiver due to obstructions was an issue. Based on this research, there is significant promise in utilizing Bluetooth to detect worker proximity to processes that represent exposure risks to long-term health hazards.

Hubbs, A., et al. (2005). "Abrasive blasting agents: designing studies to evaluate relative risk." J Toxicol Environ Health A 68(11-12): 999-1016.

Workers exposed to respirable crystalline silica used in abrasive blasting are at increased risk of developing a debilitating and often fatal fibrotic lung disease called silicosis. The National Institute for Occupational Safety and Health (NIOSH) recommends that silica sand be prohibited as abrasive blasting material and that less hazardous materials be used in blasting operations. However, data are needed on the relative risks associated with exposure to abrasive blasting materials other than silica. NIOSH has completed acute studies in rats (Hubbs et al., 2001; Porter et al., 2002). To provide dose-response data applicable to making recommendation for occupational exposure limits, NIOSH has collaborated with the National Toxicology Program (NTP) to design longer term studies with silica substitutes. For risk assessment purposes, selected doses will include concentrations that are relevant to human exposures. Rat lung burdens achieved should be comparable to those estimated in humans with working lifetime exposures, even if this results in "overloading" doses in rats. To quantify both dose and response, retained particle burdens in the lungs and lung-associated lymph nodes will be measured, as well as biochemical and pathological indices of pulmonary response. This design will facilitate assessment of the pulmonary fibrogenic potential of inhaled abrasive blasting agents at occupationally relevant concentrations.

Kalil, A. J., et al. (2004). "Time variant exposure analysis (TVEA): a measurement tool for characterizing particulate exposure determinants in construction." J Occup Environ Hyg 1(12): 816-825.

A work sampling-based approach, time variant exposure analysis (TVEA), was developed for assessment of determinants for particulate air contaminants in dynamic construction environments. To use TVEA, the field researcher records observations at fixed intervals to systematically survey over 30 potential determinants that could affect exposure to three types of particulate matter: quartz-containing dusts, diesel exhaust, and a general grouping of "other particles" that includes welding fume and wood dust. Two field studies were conducted to address questions of inter-rater reliability (n = 20) and coding interval appropriateness (n = 21) for the TVEA method. At least substantial inter-rater agreement (kappa > 0.60) was obtained for the TVEA variables related to tool or machine use, process, material, source intensity, and source orientation. Kappa values for source direction (0.22-0.38) and number of sources (0.38-0.60) showed comparatively lower agreement for all particulate types. Observation interval appropriateness was analyzed using linear regression to compare a 5-min observation interval "gold standard" with alternate intervals. Regression statistics indicated that while 30 min is an acceptable interval for exposure assessment, 15 min optimizes precision and practicality by ensuring that 95% of all observations differ less than ten percentage points from

the "true" values. TVEA is a useful exposure assessment tool for the dynamic construction environment. It is flexible in that only those determinants that are of interest need be coded and the coding interval can be adjusted to accommodate the level of precision desired.

Landrigan, P. J., et al. (2004). "Health and environmental consequences of the world trade center disaster." Environ Health Perspect 112(6): 731-739.

The attack on the World Trade Center (WTC) created an acute environmental disaster of enormous magnitude. This study characterizes the environmental exposures resulting from destruction of the WTC and assesses their effects on health. Methods include ambient air sampling; analyses of outdoor and indoor settled dust; high-altitude imaging and modeling of the atmospheric plume; inhalation studies of WTC dust in mice; and clinical examinations, community surveys, and prospective epidemiologic studies of exposed populations. WTC dust was found to consist predominantly (95%) of coarse particles and contained pulverized cement, glass fibers, asbestos, lead, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and polychlorinated furans and dioxins. Airborne particulate levels were highest immediately after the attack and declined thereafter. Particulate levels decreased sharply with distance from the WTC. Dust pH was highly alkaline (pH 9.0-11.0). Mice exposed to WTC dust showed only moderate pulmonary inflammation but marked bronchial hyperreactivity. Evaluation of 10,116 firefighters showed exposure-related increases in cough and bronchial hyperreactivity. Evaluation of 183 cleanup workers showed new-onset cough (33%), wheeze (18%), and phlegm production (24%). Increased frequency of new-onset cough, wheeze, and shortness of breath were also observed in community residents. Follow-up of 182 pregnant women who were either inside or near the WTC on 11 September showed a 2-fold increase in small-for-gestational-age (SGA) infants. In summary, environmental exposures after the WTC disaster were associated with significant adverse effects on health. The high alkalinity of WTC dust produced bronchial hyperreactivity, persistent cough, and increased risk of asthma. Plausible causes of the observed increase in SGA infants include maternal exposures to PAH and particulates. Future risk of mesothelioma may be increased, particularly among workers and volunteers exposed occupationally to asbestos. Continuing follow-up of all exposed populations is required to document the long-term consequences of the disaster.

Lee, D. J., et al. (2007). "Healthcare provider smoking cessation advice among US worker groups." Tob Control 16(5): 325-328.

OBJECTIVE: Among workers in dusty occupations, tobacco use is particularly detrimental to health because of the potential synergistic effects of occupational exposures (for example, asbestos) in causing disease. This study explored the prevalence of smoking and the reported smoking cessation discussion with a primary healthcare provider (HCP) among a representative sample of currently employed US worker groups. METHODS: Pooled data from the 1997-2003 National Health Interview Survey (NHIS) were used to estimate occupation specific smoking rates (n = 135,412). The 2000 NHIS Cancer Control Module was used to determine (among employed smokers with HCP visits) the prevalence of being advised to quit smoking by occupation (n = 3454). RESULTS: The average annual prevalence of current smoking was 25% in all workers. In 2000, 84% of smokers reported visiting an HCP during the past 12 months; 53% reported being advised by their physician to quit smoking (range 42%-66% among 30 occupations). However, an estimated 10.5 million smokers were not advised to quit smoking by their HCP. Workers with potentially increased occupational exposure to dusty

work environments (including asbestos, silica, particulates, etc), at high risk for occupational lung disease and with high smoking prevalence, had relatively low reported discussions with an HCP about smoking cessation, including farm workers (30% overall smoking prevalence; 42% told to quit), construction and extractive trades (39%; 46%), and machine operators/tenderers (34%; 44%). CONCLUSION: The relatively low reported prevalence of HCP initiated smoking cessation discussion, particularly among currently employed workers with potentially synergistic occupational exposures and high current smoking prevalence, needs to be addressed through educational campaigns targeting physicians and other HCPs.

Lee, T., et al. (2016). "Silica Measurement with High Flow Rate Respirable Size Selective Samplers: A Field Study." Ann Occup Hyg 60(3): 334-347.

High and low flow rate respirable size selective samplers including the CIP10-R (10 l min(-1)), FSP10 (11.2 l min(-1)), GK2.69 (4.4 l min(-1)), 10-mm nylon (1.7 l min(-1)), and Higgins-Dewell type (2.2 l min(-1)) were compared via side-by-side sampling in workplaces for respirable crystalline silica measurement. Sampling was conducted at eight different occupational sites in the USA and five different stonemasonry sites in Ireland. A total of 536 (268 pairs) personal samples and 55 area samples were collected. Gravimetric analysis was used to determine respirable dust mass and X-ray diffraction analysis was used to determine quartz mass. Ratios of respirable dust mass concentration, quartz mass concentration, respirable dust mass, and quartz mass from high and low flow rate samplers were compared. In general, samplers did not show significant differences greater than 30% in respirable dust mass concentration and quartz mass concentration when outliers (ratio <0.3 or >3.0) were removed from the analysis. The frequency of samples above the limit of detection and limit of quantification of quartz was significantly higher for the CIP10-R and FSP10 samplers compared to low flow rate samplers, while the GK2.69 cyclone did not show significant difference from low flow rate samplers. High flow rate samplers collected significantly more respirable dust and quartz than low flow rate samplers as expected indicating that utilizing high flow rate samplers might improve precision in quartz measurement. Although the samplers did not show significant differences in respirable dust and quartz concentrations, other practical attributes might make them more or less suitable for personal sampling.

Lofgren, D. J., et al. (2004). "Silica and noise exposure during installation of fibercement siding." J Occup Environ Hyg 1(1): D1-6.

(OSHA Compliance Issues column)

Marin, L. S. and C. Roelofs (2018). "Engaging Small Residential Construction Contractors in Community-Based Participatory Research to Promote Safety." Ann Work Expo Health 62(suppl_1): S72-S80.

Construction is a large employment sector with a high prevalence of small businesses. Despite the high injury rates reported for employees of small construction firms, these firms are under-represented in occupational safety research studies. Such studies are needed to understand barriers experienced by these firms and to examine ways to overcome them. However, challenges accessing and recruiting this hard-to-reach population are frequently reported. Traditional approaches of recruiting through unions or workers' compensation insurers may not be appropriate or effective for small construction businesses. Previous studies have demonstrated the value of academic collaborations with community-based organizations for

recruiting participants from hard-to-reach populations for research studies. In accordance with the principles of Community-Based Participatory Research (CBPR), we formed a recruitment team comprised of staff from a local union, a community organization, and a community outreach team to recruit small construction contractors in Lawrence, MA. Media marketing strategies, participation in community events, exploring neighborhoods in search of ongoing residential projects, and partnership with vocational training institutions and building trade associations were some of the strategies implemented during this project. We recruited 118 contractors, supervisors, and foremen from more than 50 construction firms across the Greater Lawrence area to participate in an intervention project to reduce falls and silica exposure. The CBPR approach facilitated the development and implementation of recruitment strategies that resulted in the participation of a significant number of hard-to-reach small construction contractors.

Marín, L. S. and C. Roelofs (2017). "Promoting Construction Supervisors' Safety-Efficacy to Improve Safety Climate: Training Intervention Trial." Journal of Construction Engineering and Management 143(8): 04017037.

Hispanic workers may be more likely to experience a deficient safety climate on construction worksites and it may account for their disproportionate injury rates. As part of a large study, the authors developed and implemented a 5-h training program to improve construction supervisors' safety-efficacy, in order to enhance the safety climate on construction worksites. The training program covered fall prevention, silica exposure, leadership, communication, and safety planning. This study evaluated pretraining and posttraining changes and safety-efficacy six months posttraining. A total of 118 supervisors, contractors, and workers from more than 50 construction firms in Massachusetts attended the training. Statistically significant improvements were observed in participants' safety knowledge, skills, and attitudes. Six-months postintervention, 58% of supervisors, contractors, or both, perceived that the training contributed "a lot" to their ability to communicate effectively with Spanish-speaking workers, to take on a safety leadership role (52%), and to conduct effective training (62%). This study determined that when supervisors perceive that they have the knowledge, skills, and confidence to make changes, they may better fulfill their role as a safety leader. Construction supervisor training courses might be revised to include leadership and effective communication topics. - See more at: http://ascelibrary.org/doi/full/10.1061/%28ASCE%29CO.1943-7862.0001330#sthash.bOwqmOhn.dpuf

Mazurek, J. M. and M. D. Attfield (2008). "Silicosis mortality among young adults in the United States, 1968-2004." Am J Ind Med 51(8): 568-578.

BACKGROUND: To describe silicosis deaths in young (aged 15-44) adults in the U.S. during 1968-2004. METHODS: We analyzed the National Center for Health Statistics multiple cause-of-death records. RESULTS: Compared with silicosis decedents aged >or=45 years (n = 15,643), young decedents (n = 237) were more likely to have silicosis listed as the underlying cause of death (74.3% vs. 48.2%, P < 0.001), to be female (9.3% vs. 2.2%, P < 0.001) and black (37.1% vs. 11.7%, P < 0.001). Twenty-nine young silicosis decedents had industry and occupation information available. Occupations in construction and manufacturing industries were associated with significantly elevated proportionate mortality ratios for young silicosis deaths. CONCLUSIONS: Silicosis deaths occur among young adults. Because these deaths are

likely to reflect more intense and recent exposures, the follow-back investigations into the work sites where these individuals were exposed to silica should be conducted.

Meeker, J. D., et al. (2009). "Engineering control technologies to reduce occupational silica exposures in masonry cutting and tuckpointing." Public Health Rep 124 Suppl 1: 101-111.

OBJECTIVES: A number of tasks in construction generate worker overexposures to respirable crystalline silica dust, which is a significant contributor to occupational mortality and morbidity. This study evaluated the performance of commercially available engineering controls used in dusty construction tasks commonly performed by bricklayers. METHODS: Local exhaust ventilation (LEV) controls for a portable abrasive cutter and for tuckpointing grinders were examined at a bricklayers' training center, as were two stationary wet saws. Personal breathing zone air samples were collected with and without the use of LEV or water suppression during simulated concrete block cutting, brick cutting, and tuckpointing. RESULTS: Compared with the use of no exposure control during block and brick cutting, the portable LEV unit significantly reduced mean respirable quartz exposures by 96% for block cutting and 91% for brick cutting ($p < 0.01$). The use of stationary wet saws was also associated with 91% reductions in exposure ($p < 0.01$). For tuckpointing, the reductions in mean respirable quartz concentrations were between 91% and 93% with the LEV controls ($p < 0.05$). CONCLUSIONS: Reductions of up to 96% in mean respirable quartz concentration were observed between control and no-control scenarios. These reductions with commercially available off-the-shelf tools demonstrate the effectiveness of engineering control interventions to reduce crystalline silica exposures in construction. Strategies to further improve control performance and approaches for increasing control interventions in construction are needed.

Meeker, J. D., et al. (2005). "Exposure to silica and metals among painters using specular hematite abrasive." J Occup Environ Hyg 2(8): D60-64.

Case study: Exposure to silica and metals among painters using specular hematite abrasive

Meeker, J. D., et al. (2006). "Comparison of occupational exposures among painters using three alternative blasting abrasives." J Occup Environ Hyg 3(9): D80-84.

Comparison of occupational exposures among painters using three alternative blasting abrasives

Methner, M. M. (2000). "Identification of potential hazards associated with new residential construction." Appl Occup Environ Hyg 15(2): 189-192.

There were several advantages and limitations of this observational study. The most important advantage of this study was the opportunity to observe residential construction workers performing their jobs. By observing work practices, valuable information was gathered about specific trades and their potential exposure to various chemical and physical agents. This information will be useful in guiding subsequent exposure assessments. Probably the greatest limitation of this study was the lack of participation by homebuilders. Ideally, observations of construction processes would have been more objective if the study included the participation of more than one homebuilder. Aside from one worker who was observed to wear safety glasses, leather gloves, and a dust mask, virtually no personal protective equipment (PPE) was observed onsite. Often small contractors do not have the financial resources necessary to

procure the appropriate PPE and issue these items to the workers. Based on hazard prevalence, professional judgement, and the degree of hazardous product use, potential exposures that warrant quantitative sampling efforts during Phase 2 of this study are: bulldozer/backhoe operators--noise, vibration, diesel exhaust; concrete workers--naphtha, mineral spirits, Portland cement; asphalt workers--petroleum hydrocarbons, asphalt, mineral spirits; plumbers--methylethyl ketone, acetone, tetrahydrofuran, cyclohexanone; drywall finishers--total and respirable dust, hexane, acetone; painters--ethylene glycol, VOCs; masons--dust (during the preparation of mortar); floor preparation technicians--total and respirable dust; and ceramic tile installers--toluene, naphtha, silica (from grout powder).

Middaugh, B., et al. (2012). "Evaluation of cut-off saw exposure control methods for respirable dust and crystalline silica in roadway construction." J Occup Environ Hyg 9(3): 157-165.

Dust reduction equipment adapted for single-person operation was evaluated for gas-powered, commercially available cut-off saws during concrete curb cutting. Cutting was performed without dust control and with two individual exposure control methods: wet suppression and local exhaust ventilation (LEV). The wet suppression system comprised a two-nozzle spray system and a 13.3-L hand-pressurized water supply system with an optimum mean flow rate of 0.83 L/min for 16 min of cutting. The LEV system consisted of a spring-loaded guard, an 18.9-L collection bag, and a centrifugal fan with an estimated exhaust rate of 91 ft(3)/min. Task-based, personal filter samples were obtained for four saw operators during cutting durations of 4 to 16 min on five job sites. Seventeen filter samples were collected without dust control, 14 with wet suppression, and 12 with LEV, yielding a geometric mean respirable dust concentration of 16.4 mg/m(3), 3.60 mg/m(3), and 4.40 mg/m(3), respectively. A dust reduction of 78.0% for wet suppression and 73.2% for LEV was observed vs. no dust control. A statistically significant difference ($p < 0.001$) was also revealed for wet suppression and LEV when compared with no dust control; however, a significant difference ($p = 0.09$) was not observed between wet suppression and LEV. Despite these significant dust reductions, workers are still projected to exceed the ACGIH 8-hr time-weighted average threshold limit value for quartz (0.025 mg/m(3)) in less than 1 hr of cutting for both dust control methods. Further research is still needed to improve dust reduction and portability of both control methods, but the current LEV system offers important advantages, including a drier, less slippery work area and year-round functionality in cold weather.

Miller, B. M., et al. (2018). "Understanding the Economic Benefit Associated with Research and Services at the National Institute for Occupational Safety and Health: An Approach and Three Case Studies." Rand Health Q 8(1): 1.

The National Institute for Occupational Safety and Health (NIOSH) asked the RAND Corporation to develop an approach, reported here, for estimating the economic benefit of NIOSH research, using three case studies. The cases provide concrete illustrations of the ways in which NIOSH research could affect worker health and safety practices and outcomes, as well as some initial estimates of the economic benefit associated with those impacts. The authors selected the case studies to illustrate variation in types of NIOSH research and in intended users. The first case study examines research to develop, test, and support implementation of engineering control measures to limit exposure to silica among road construction workers. This case study offers an example of NIOSH's intervention and surveillance research and provision of technical assistance. The second case study involves two NIOSH studies that strengthened

the evidence base about the linkage between firefighting activities and increased risk of certain cancers among firefighters. This case study provides an example of etiological and exposure surveillance research, coupled with an intervention study. The third case study involves a NIOSH evaluation of the effectiveness of Ohio's Safety Intervention Grant Program in reducing the prevalence and costs of workplace injuries. This case study illustrates intervention research targeting government organizations. The first and second case studies led to the development of control technologies, and all three case studies involved dissemination and stakeholder engagement efforts that promoted the adoption of risk-reducing technologies and practices.

Oliver, C. and H. Miracle-McMahill (2003). "Asthma in Heavy and Highway Construction Workers Exposed to Silica (CPWR Report)."

Oliver, L. C. and H. Miracle-McMahill (2006). "Airway disease in highway and tunnel construction workers exposed to silica." Am J Ind Med 49(12): 983-996.

BACKGROUND: Construction workers employed in a unique type of tunnel construction known as tunnel jacking were exposed over an 18-month period to respirable crystalline silica at concentrations that exceeded the OSHA permissible exposure limit. The present study examines workplace exposures and occurrence of airway disease in these workers. METHODS: Medical and occupational histories and chest radiographs were obtained on 343 active construction workers who had worked on the site during the period in question. Chest radiographs were interpreted according to the ILO-1980 system of classification. Standardized questions were used to develop an algorithm to define symptoms consistent with asthma (SCA) and to determine these respiratory outcomes: chronic bronchitis, shortness of breath (SOB), and physician-diagnosed asthma (current vs. not current). Relationships with each of three work activities were examined: slurry wall breakthrough (SWB), chipping caisson overpour, and tunneling/mining. RESULTS: Participants included laborers, carpenters, tunnel workers, ironworkers, operating engineers, and electricians. No cases of silicosis were found on chest X-ray. Overall prevalence of chronic bronchitis, SCA, SOB, and physician-diagnosed asthma was 10.7%, 25%, 29%, and 6.6%, respectively. Odds ratios (OR) for carpenters compared to laborers were significantly elevated for chronic bronchitis, SCA, and SOB. SWB was associated with chronic bronchitis and SCA (OR 4.93, 95% CI = 1.01, 24.17; OR 3.32, 95% CI = 1.25, 8.84, respectively). The interaction between SWB, SCA, and trade was significant for carpenters (OR 6.87, 95% CI = 1.66, 28.39). Inverse trends were observed for months on the site and chronic bronchitis, SCA, and SOB (P = 0.0374, 0.0006, and 0.0307, respectively). CONCLUSIONS: Tunnel construction workers exposed to respirable crystalline silica and cement dust are at increased risk for airway disease. Extent of risk varies by trade and work activity. Our data indicate the importance of bystander exposures and suggest that tunnel jacking may be associated with greater risk compared to more traditional methods of tunnel construction. A healthy worker effect is suggested.

Oliver, L. C., et al. (2001). "Respiratory symptoms and lung function in workers in heavy and highway construction: a cross-sectional study." Am J Ind Med 40(1): 73-86.

BACKGROUND: Occupational exposures for workers in heavy and highway (HH) construction include cement-containing dusts and diesel exhaust (DE). To investigate possible health effects, respiratory symptoms and lung function were examined in laborers, tunnel workers (TW), and operating engineers (OE) in HH and tunnel construction. The principal

outcome of interest was airways disease. METHODS: Subjects were recruited through their unions. Medical and occupational histories and flow-volume loops were obtained. Based on self-report, asthma and chronic bronchitis were categorized as (1) physician-diagnosed or (2) for asthma, undiagnosed likely, and (3) for chronic bronchitis, symptomatic. Trade and time in the union were used as surrogates of exposure. Prevalence of asthma and chronic bronchitis, lung function outcome, and relationships with exposure variables were examined. RESULTS: Data were obtained on 389 workers: 186 laborers, 45 TWs, and 158 OEs. Prevalence of asthma was 13 and 11.4% for laborers (including TW) and OEs, respectively, and of symptomatic chronic bronchitis, 6.5 and 1.9%, respectively. Odds ratios (OR) for undiagnosed asthma likely were significantly elevated in TWs compared to OEs, and marginally elevated for chronic bronchitis. Inverse relationships were observed between time in the union, and risk for asthma and chronic bronchitis. Asthma (physician-diagnosed or undiagnosed likely) predicted lower FEV(1). Current cigarette use was associated with chronic bronchitis but not asthma. CONCLUSIONS: TWs, laborers, and OEs in HH construction are at increased risk for asthma. TWs also appear to be at increased risk for chronic bronchitis. Our data suggest that symptomatic workers are self-selecting out of their trade. Asthma was associated with lower lung function in those affected.

Qi, C., et al. (2016). "On the Characterization of the Generation Rate and Size-Dependent Crystalline Silica Content of the Dust from Cutting Fiber Cement Siding." Ann Occup Hyg 60(2): 220-230.

A laboratory testing system was developed to systematically characterize the dust generation rate and size-dependent crystalline silica content when cutting or shaping silica containing materials. The tests of cutting fiber cement siding in this system verify that it provides high test repeatability, making it suitable for the targeted characterizations. The mass-based size distributions obtained from a gravimetric-based instrument and a direct reading instrument both show bimodal lognormal distributions with a larger mode ~13 microm and another mode <5 microm for the dusts from cutting four different brands of fiber cement siding. The generation rates of respirable dust obtained from the two instruments are comparable, and the results from each instrument are similar for the four brands. The silica content in the airborne dusts, however, strongly depends on the amount of silica used in the respective product. It is also observed that the silica content in the airborne dust from cutting the four brands of fiber cement siding showed the same trend of an increase with the aerodynamic diameter of the dust, approaching the silica content levels found in their respective bulk samples. Combining the results for both the dust size distribution and size-dependent silica content, it is found that most of the respirable crystalline silica (RCS) resides in the dust ~2.5 microm in aerodynamic diameter. These results would help guide the development of specific engineering control measures targeted at lowering workers' exposure to RCS while cutting fiber cement siding. With the high repeatability using the laboratory testing system, the dust generation rate could then be characterized under different operating conditions, and with the deployment of various engineering control measures. This would greatly facilitate the systematic evaluation of the control effectiveness and the selection of the optimal control solutions for field trials.

Rappaport, S. M., et al. (2003). "Excessive exposure to silica in the US construction industry." Ann Occup Hyg 47(2): 111-122.

Exposures to respirable dust and silica were investigated among 36 construction sites in the USA. Personal measurements (n = 151) were analyzed from 80 workers in four trades, namely bricklayers, painters (while abrasive blasting), operating engineers and laborers. Painters had the highest exposures (median values for respirable dust and silica: 13.5 and 1.28 mg/m3, respectively), followed by laborers (2.46 and 0.350 mg/m3), bricklayers (2.13 and 3.20 mg/m3) and operating engineers (0.720 and 0.075 mg/m3). Mixed models were fitted to the log-transformed air levels to estimate the means and within- and between-worker variance components of the distributions in each trade. We refer to the likelihood that a typical worker from a given trade would be exposed, on average, above the occupational exposure limit (OEL) as the probability of overexposure. Given US OELs of 0.05 mg/m3 for respirable silica and 3 mg/m3 for respirable dust, we estimated probabilities of overexposure as between 64.5 and 100% for silica and between 8.2 and 89.2% for dust; in no instance could it be inferred with certainty that this probability was <10%. This indicates that silica exposures are grossly unacceptable in the US construction industry. While engineering and administrative interventions are needed to reduce overall air levels, the heterogeneous exposures among members of each trade suggest that controls should focus, in part, upon the individual sites, activities and equipment involved. The effects of current controls and workplace characteristics upon silica exposures were investigated among operating engineers and laborers. Silica exposures were significantly reduced by wet dust suppression (~3-fold for laborers) and use of ventilated cabs (~6-fold for operating engineers) and were significantly increased indoors (about 4-fold for laborers). It is concluded that urgent action is required to reduce silica exposures in the US construction industry.

Rempel, D., et al. (2019). "Pneumatic rock drill vs. electric rotary hammer drill: Productivity, vibration, dust, and noise when drilling into concrete." Appl Ergon 74: 31-36.

OBJECTIVES: Both pneumatic rock drills and electric rotary hammer drills are used for drilling large holes (e.g., 10-20 mm diameter) into concrete for structural upgrades to buildings, highways, bridges, and airport tarmacs. However, little is known about the differences in productivity, and exposures to noise, handle vibration, and dust between the two types of drills. The aim of this study was to compare these outcomes with similar mass electric rotary and pneumatic rock drills drilling into concrete block on a test bench system. METHOD: Three experiments were conducted on a test bench system to compare an electric (8.3 kg) and pneumatic drill (8.6 kg) on (1) noise and handle vibration, (2) respirable silica dust, and (3) drilling productivity. The test bench system repeatedly drilled 19 mm diameter x 100 mm depth holes into cured concrete block while the respective exposure levels were measured following ISO standards. RESULTS: Productivity levels were similar between the electric and the pneumatic drill (9.09 mm/s vs. 8.69 mm/s ROP; p = 0.15). However, peak noise (L(Peak): 117.7 vs. 139.4 dBC; p = 0.001), weighted total handle vibration (a(hw): 7.15 vs. 39.14 m/s(2); p = 0.002), and respirable silica dust levels (0.55 vs. 22.23 mg/m(3); p = 0.003) were significantly lower for the electric than the pneumatic drill. DISCUSSION: While there were no differences in drilling productivity between an electric and pneumatic drill of similar mass, there were substantial differences in exposure levels of noise, handle vibration, and respirable silica dust. Structural contractors should switch from pneumatic rock drills to electric rotary hammer drills for structural drilling into concrete in order to reduce worker exposures to the hazards of noise, hand vibration, and silica dust.

Rempel, D., et al. (2019). "Effect of hollow bit local exhaust ventilation on respirable quartz dust concentrations during concrete drilling." J Occup Environ Hyg 16(5): 336-340.

Drilling large holes (e.g., 10-20 mm diameter) into concrete for structural upgrades to buildings, highways, bridges, and airport runways can produce concentrations of respirable silica dust well above the ACGIH((R)) Threshold Limit Value (TLV((R)) = 0.025 mg/m(3)). The aim of this study was to evaluate a new method of local exhaust ventilation, hollow bit dust extraction, and compare it to a standard shroud local exhaust ventilation and to no local exhaust ventilation. A test bench system was used to drill 19 mm diameter x 100 mm depth holes every minute for one hour under three test conditions: no local exhaust ventilation, shroud local exhaust ventilation, and hollow bit local exhaust ventilation. There were two trials for each condition. Respirable dust sampling equipment was placed on a "sampling" mannequin fixed behind the drill and analysis followed ISO and NIOSH methods. Without local exhaust ventilation, mean respirable dust concentration was 3.32 (+/- 0.65) mg/m(3) with a quartz concentration of 16.8% by weight and respirable quartz dust concentration was 0.55 (+/- 0.05) mg/m(3); 22 times the ACGIH TLV. For both LEV conditions, respirable dust concentrations were below the limits of detection. Applying the 16.8% quartz value, respirable quartz concentrations for both local exhaust ventilation conditions were below 0.007 mg/m(3). There was no difference in respirable quartz dust concentrations between the hollow bit and the shroud local exhaust ventilation systems; both were below the limits of detection and well below the ACGIH TLV. Contractors should consider using either local exhaust ventilation method for controlling respirable silica dust while drilling into concrete.

Reynolds, K. and J. Jerome (2021). "Silicosis." Workplace Health Saf 69(1): 51.

Occupational exposures to dust with elevated levels of respirable crystalline silica in artificial stone increase workers' risk for silicosis.

Ringen, K., et al. (2023). "How much have adverse occupational health outcomes among construction workers improved over time? Evidence from 25 years of medical screening." Am J Ind Med 66(1): 18-29.

BACKGROUND: Construction workers have always had a high risk of occupational illnesses. We used 25 years of data from a medical screening program serving older construction workers to determine how much health outcomes have improved over the past 60 years. METHODS: We investigated changes in relative risk for chest radiographs consistent with pneumoconiosis, COPD by spirometry, lung cancer mortality, and audiometry-assessed hearing impairment among workers participating in a medical screening program. Results were stratified by decade of first construction employment: before 1960, 1960-1969, 1970-1979, 1980-1989, and after 1990. Poisson and Cox regression analyses assessed relative risk by decade adjusted for age, sex, smoking, and years of construction trade work. RESULTS: Subjects were 94% male and, on average, 60 years old with 25 years of construction work. When compared to workers employed before 1960, those first employed after 1990 experienced the following reductions in model-adjusted relative risks: chronic obstructive pulmonary disease, 32%; all pneumoconiosis, 68%; parenchymal abnormalities, 35%; pleural abnormalities, 71%; hearing impairment, 20%; and lung cancer mortality, 48%. Risks started to decline in the 1960s with greatest reductions among workers first employed after 1970. CONCLUSIONS: This study demonstrates the positive impact that adoption of occupational health protections have had over the past 60 years. The greatest risk reductions were observed

for outcomes with strong regulatory and legal incentives to reduce exposures and associated risks, such as those associated with inhalation hazards (asbestos and silica), while lowest improvement was for hearing impairment, for which little regulatory enforcement and few prevention incentives have been adopted.

Roelofs, C., et al. (2011). "A qualitative investigation of Hispanic construction worker perspectives on factors impacting worksite safety and risk." Environ Health 10: 84.

BACKGROUND: Hispanic workers have higher rates of injury and death on construction worksites than workers of other ethnicities. Language barriers and cultural differences have been hypothesized as reasons behind the disparate rates. METHODS: We conducted two series of focus groups with union and non-union Hispanic construction workers to ask them about their perceptions of the causes for the unequal rates. Spanish transcripts were translated and coded in QSR NVivo software for common themes. RESULTS: Workers reported a difficult work environment characterized by supervisor pressure, competition for jobs and intimidation with regard to raising safety concerns. Language barriers or cultural factors were not strongly represented as causative factors behind the rates. CONCLUSION: The results of this study have informed the development of an intervention trial that seeks to prevent falls and silica dust exposure by training contractors employing Hispanic construction workers in the elements of safety leadership, including building respect for their Hispanic workers and facilitating their participation in a safety program.

Salg, J. and T. Alterman (2005). "A proportionate mortality study of bricklayers and allied craftworkers." Am J Ind Med 47(1): 10-19.

BACKGROUND: Mortality among members of the International Union of Bricklayers and Allied Craftworkers (IUBAC) is examined. Bricklayers and allied craft workers may be exposed to cobalt, epoxy resins, pitch, lime, and to lung carcinogens such as asbestos, silica, and nickel. METHODS: Proportionate mortality ratios (PMRs) were computed using US age-, gender-, and race-specific mortality rates for members who died during 1986-1991. RESULTS: Statistically significant PMRs among white men were found for cancers of the esophagus (PMR=134), stomach (PMR=131), respiratory system, trachea, bronchus, and lung (PMR=144), other parts of the respiratory system (PMR=216), other and unspecified sites (PMR=125). Elevated PMRs were also found for other diseases of the blood and blood forming organs (PMR=201), emphysema (PMR=133) and for asbestosis (PMR=554), and other respiratory diseases (PMR=119). CONCLUSIONS: Results are consistent with those found in previous studies, and suggest the need for intervention activities directed at the prevention of these cancers, and other respiratory diseases.

Shepherd, S. and S. Woskie (2013). "Controlling dust from concrete saw cutting." J Occup Environ Hyg 10(2): 64-70.

Cutting concrete with gas-powered saws is ubiquitous in the construction industry and a source of exposure to respirable crystalline silica. Volunteers from the New England Laborers Training Center were recruited to participate in a field experiment examining dust reductions through the use of water, from a hose and from a sprayer, as a dust control. In four series of tests, reinforced concrete pipe was cut under both "dry" and "wet" control conditions. Overall, the geometric mean respirable dust concentration for "dry" cutting (14.396 mg/m(3)) exceeded both types of water-based controls by more than tenfold. Wet cutting reduced the respirable dust

concentration by 85% compared with dry cutting when comparing tests paired by person and saw blade (n = 79 pairs). Using a respirable cyclone, a total of 178 samples were taken. Due to the high variability in dust exposure found in this and other studies of saw cutting, the data were examined for potential exposure determinants that contribute to that variability. Using mixed models, three fixed effects were statistically significant: control condition, worker experience, and location. A random effect for subject was included in the model to account for repeated measures. When each of the significant fixed effects was included with the random effect, it was apparent that inclusion of worker experience or location reduced the between-worker component of exposure variability, while inclusion of control condition (wet vs. dry) explained a large portion of the within-subject variability. Overall, the fixed effect variable for control condition explained the largest fraction of the total exposure variability.

Shepherd, S. and S. R. Woskie (2010). "Case study to identify barriers and incentives to implementing an engineering control for concrete grinding dust." Journal of Construction Engineering and Management 136(11): 1238-1248.

Research has indicated that respirable crystalline silica dust exposure is a serious health hazard in the construction industry. One source of this hazard is the dust generated by drilling, sawing, chipping, and grinding concrete. There are several options for controlling this hazard, one of which is the use of local exhaust ventilation (LEV) directly attached to the cutting tool. Implementing an engineering control presents a challenge on the construction work site where it is often difficult to determine who will take the initiative for introducing an innovative strategy. This study examines the implementation of an LEV system on an overhead grinder illustrating the roles that various members of the construction team played. The results of the case study found that key factors that affected implementation were: (1) a cooperative relationship between individuals employed by the general contractor and the concrete subcontractor; (2) the effect of high airborne dust levels on scheduling the work of other subcontractors; (3) the public relations effects of high dust levels in a downtown area; and (4) the concrete subcontractor perceived benefits that exceeded the short-term cost of the intervention.

Shepherd, S., et al. (2009). "Reducing silica and dust exposures in construction during use of powered concrete-cutting hand tools: efficacy of local exhaust ventilation on hammer drills." J Occup Environ Hyg 6(1): 42-51.

Concrete cutting in construction is a major source of exposure to respirable crystalline silica. To reduce exposures, local exhaust ventilation (LEV) may be integrated into the hand tools used in concrete cutting. Volunteers from the New England Laborers Training Center participated in a field study focused on the use of LEV on concrete-cutting hammer drills. A randomized block design field experiment employing four workers measured the efficacy of four hood-vacuum source combinations compared with no LEV in reducing dust and silica exposures. Using four-stage personal cascade impactors (Marple 294) to measure dust exposure, a total of 18 personal samples were collected. Reductions of over 80% in all three biologically relevant size fractions of dust (inhalable, thoracic, and respirable) were obtained by using any combination of hood and vacuum source. This study found that respirable dust concentrations were reduced from 3.77 mg/m(3) to a range of 0.242 to 0.370 mg/m(3); thoracic dust concentrations from 12.5 mg/m(3) to a range of 0.774 to 1.23 mg/m(3); and inhalable dust concentration from 47.2 mg/m(3) to a range of 2.13 to 6.09 mg/m(3). Silica concentrations

were reduced from 0.308 mg/m(3) to a range of 0.006 to 0.028 mg/m(3) in the respirable size fraction, from 0.821 mg/m(3) to a range of 0.043 to 0.090 mg/m(3) in the thoracic size fraction, and from 2.71 mg/m(3) to a range of 0.124 to 0.403 mg/m(3) in the inhalable size fraction. Reductions in dust concentrations while using the four LEV systems were not statistically significantly different from each other.

Simmons, C. E., et al. (2011). "Factors influencing dust exposure: finishing activities in drywall construction." J Occup Environ Hyg 8(5): 324-336.

Sanding drywall joint compound is a dusty construction activity. We studied potential factors influencing exposure to respirable and total dust for sanders and bystanders in the area of drywall joint compound finishing in 17 test events within a room-scale isolation chamber. We found the air change rate to be negatively correlated with dust C(twa) both in the sander's personal breathing zone and surrounding area. We could not conclude that sanding tool type systematically influences dust C(twa), but the use of 80-grit abrasive was associated with the highest dust C(twa). We found respirable dusts were uniformly dispersed 1-8.2 m from sanding activities at a fixed location. As anticipated, both respirable and total dust C(twa) in the sander's personal breathing zone are higher than in the surrounding area. The respirable fraction of the total dust mass C(twa) was greater in the surrounding area than in the sander's personal breathing zone. Respirable dust concentrations measured in real time increased over the duration of sanding, exhibiting a temporal trend that is similar to that predicted by the well-mixed box model with contaminant removal by mechanical ventilation only, and continuous emission. Dust concentrations returned to pre-activity (background) levels 2-4 hr after cessation of the sanding activity.

Szeinuk, J. and E. J. Wilk-Rivard (2007). "Case report: silicatosis in a carpet installer." Environ Health Perspect 115(6): 932-935.

CONTEXT: Chronic exposure to talc in the course of carpet installation can result in pneumoconiosis. CASE PRESENTATION: We present a case of a young carpet installer who was diagnosed with silicatosis of the lung. Review of occupational history revealed that the patient had been working as a carpet installer for approximately 15 years, since he was 15 years of age. The patient was exposed to talc in the course of his work. DISCUSSION: Exposure to talc in the course of carpet installation has not been reported as a possible cause of pneumoconiosis. In this article we review different causes of silicatosis and discuss chronic exposure in the course of carpet installation and development of pneumoconiosis. In addition, we also review the relevance of mycobacterial infection in cases of silicosis and silicatosis. RELEVANCE TO CLINICAL OR PROFESSIONAL PRACTICE: Exposure to talc in the course of carpet installation should be added to conditions that can cause pneumoconioses, specifically silicatosis of the lung.

Valiante, D. J., et al. (2004). "Highway repair: a new silicosis threat." Am J Public Health 94(5): 876-880.

OBJECTIVES: We describe an emerging public health concern regarding silicosis in the fast-growing highway repair industry. METHODS: We examined highway construction trends, silicosis surveillance case data, and environmental exposure data to evaluate the risk of silicosis among highway repair workers. We reviewed silicosis case data from the construction industry in 3 states that have silicosis registries, and we conducted environmental monitoring for silica at

highway repair work sites. RESULTS: Our findings indicate that a large population of highway workers is at risk of developing silicosis from exposure to crystalline silica. CONCLUSIONS: Exposure control methods, medical screenings, protective health standards, and safety-related contract language are necessary for preventing future occupational disease problems among highway repair workers.

Virji, M. A., et al. (2002). "Analysis of quartz by FT-IR in air samples of construction dust." Appl Occup Environ Hyg 17(3): 165-175.

The construction industry is reported to have some of the highest exposures to silica-containing dust. With the designation of crystalline silica as a group I human carcinogen by the International Agency for Research on Cancer (IARC), there exists a need for an analytical method to accurately quantify low levels of quartz. A method is described that uses FT-IR for quartz analysis of personal air samples collected from heavy and highway construction sites using 4-stage personal impactors. Sample filters were ashed and 13-mm or 5-mm pellets were prepared. Absorbance spectra were collected using FT-IR at resolution of 1 cm(-1) and 64 scans per spectrum. Two spectra were collected per sample using the appropriate background spectrum subtraction. Spectral manipulations such as Fourier self-deconvolution and derivatizations were performed to improve quantification. Peak height for quartz was measured at 798 cm(-1) for quantitative analysis. The estimated limit of detection for the 5-mm pellets was 1.3 microg. Recoveries of Min-U-Sil 5 spikes showed an average of > or = 94 percent for the two pellet types. The coefficient of variation of the 5-mm pellet was 9 percent at 6 microg quartz load, and 7 percent at 62 microg load. Interferences from clay, amorphous silica, concrete, calcite, and kaolinite were investigated, these being the more likely sources of interferences in construction environment. Spikes of mixtures of amorphous silica or kaolinite with Min-U-Sil 5 showed both contaminants introduced, on average, a positive error of < 5 microg with average recoveries of 106 percent and 111 percent, respectively. Spikes of mixtures of clay or concrete with Min-U-Sil 5 showed overall average recovery of 100 percent and 90 percent, respectively, after accounting for the presence of quartz in clay and concrete. This method can quantify low levels of quartz with reasonable accuracy in the face of common contaminants found in the construction industry.

Weinstein, M., et al. (2016). "The power of local action in occupational health: the adoption of local exhaust ventilation in the Chicago tuckpointing trade." Int J Occup Environ Health 22(2): 142-150.

BACKGROUND: Silica is a pervasive and potentially deadly occupational hazard in construction. The occupational risk posed by silica has long been known, but efforts to use engineering controls to minimize dust generation in tuckpointing operations, a masonry restoration specialty, have been slow. OBJECTIVES: The objective of this study is to explore how local innovation in occupational safety and health may emerge, absent the establishment of national standards. METHOD: This study uses a case study to explore the adoption of local exhaust ventilation in tuckpointing operations in the Chicago area. Sources of data for this research include interviews with a diverse range of key informants and the review of archival material. RESULTS: This case study found local unions, municipal regulators, contractors, and major public users of construction services played a central role in the events and milestones that led to the early adoption of local exhaust ventilation in Chicago. The adoption of local exhaust ventilation technology in Chicago demonstrates the potential for local actors to fill an

important void when rulemaking in vital areas of occupational of health impedes effective national regulation.

Welch, L. S., et al. (2019). "Early detection of lung cancer in a population at high risk due to occupation and smoking." Occup Environ Med 76(3): 137-142.

OBJECTIVE: The US National Comprehensive Cancer Network (NCCN) recommends two pathways for eligibility for Early Lung Cancer Detection (ELCD) programmes. Option 2 includes individuals with occupational exposures to lung carcinogens, in combination with a lesser requirement on smoking. Our objective was to determine if this algorithm resulted in a similar prevalence of lung cancer as has been found using smoking risk alone, and if so to present an approach for lung cancer screening in high-risk worker populations. METHODS: We enrolled 1260 former workers meeting NCCN criteria, with modifications to account for occupational exposures in an ELCD programme. RESULTS: At baseline, 1.6% had a lung cancer diagnosed, a rate similar to the National Lung Cancer Screening Trial (NLST). Among NLST participants, 59% were current smokers at the time of baseline scan or had quit smoking fewer than 15 years prior to baseline; all had a minimum of 30 pack-years of smoking. Among our population, only 24.5% were current smokers and 40.1% of our participants had smoked fewer than 30 pack-years; only 43.5% would meet entry criteria for the NLST. The most likely explanation for the high prevalence of screen-detected lung cancers in the face of a reduced risk from smoking is the addition of occupational risk factors for lung cancer. CONCLUSION: Occupational exposures to lung carcinogens should be incorporated into criteria used for ELCD programmes, using the algorithm developed by NCCN or with an individualised risk assessment; current risk assessment tools can be modified to incorporate occupational risk.

Woskie, S. R., et al. (2002). "Exposures to quartz, diesel, dust, and welding fumes during heavy and highway construction." AIHA J (Fairfax, Va) 63(4): 447-457.

Personal samples for exposure to dust, diesel exhaust, quartz, and welding fume were collected on heavy and highway construction workers. The respirable, thoracic, and inhalable fractions of dust and quartz exposures were estimated from 260 personal impactor samples. Respirable quartz exposures exceeded the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) in 7-31% of cases for the trades sampled. More than 50% of the samples in the installation of drop ceilings and wall tiles and concrete finish operations exceeded the NIOSH REL for quartz. Thoracic exposures to quartz and dust exceeded respirable exposures by a factor of 4.5 and 2.8, respectively. Inhalable exposures to quartz and dust exceeded respirable exposures by a factor of 25.6 and 9.3, respectively. These findings are important due to the identification of quartz as a carcinogen by the National Toxicology Program and the International Agency for Research on Cancer. Fourteen percent of the personal samples for EC (n = 261), collected as a marker for diesel exhaust, exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) for diesel exhaust. Seventeen of the 22 (77%) samples taken during a partially enclosed welding operation reached or exceeded the ACGIH TLV of 5 mg/m3 for welding fume.

Yasui, S., et al. (2003). "Assessment of silica exposure and engineering controls during tuckpointing." Appl Occup Environ Hyg 18(12): 977-984.

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