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Asbestos in Construction:

An Interdisciplinary Annotated Bibliography

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2018

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Asbestos in Construction: An Interdisciplinary Annotated Bibliography

Bang, K. M., et al. (2008). "Asbestosis mortality surveillance in the United States, 1970-2004." Int J Occup Environ Health 14(3): 161-169.

To describe the demographic, geographic, and occupational distribution of asbestosis mortality in the United States during 1970-2004, we identified a total of 25,413 asbestosis deaths. We calculated national, state, and county death rates, age-adjusted to the 2000 U.S. standard population. We also calculated industry- and occupation-specific proportionate mortality ratios (PMRs), adjusted for age, sex, and race, and corresponding confidence intervals (CIs) using available data. The overall U.S. age-adjusted asbestosis death rate was 4.1 per million population per year; the rate for males (10.4) was nearly 35-fold higher than that for females (0.3). It increased significantly from 0.6 to 6.9 per million population from 1970 to 2000 ($p<0.001$), and then declined to 6.3 in 2004 ($p=0.014$). High asbestosis death rates occurred predominantly, though not exclusively, in coastal areas. Industries with highest PMRs included ship and boat building and repairing (18.5; 95% CI 16.3-20.9) and miscellaneous nonmetallic mineral and stone products (15.9; 95% CI 13.0-19.5). Occupations with highest PMRs included insulation workers (109.2; 95% CI 93.8-127.2) and boilermakers (21.3; 95% CI 17.0-26.6).

Bang, K. M., et al. (2006). "Malignant mesothelioma mortality in the United States, 1999-2001." Int J Occup Environ Health 12(1): 9-15.

Malignant mesothelioma is strongly associated with asbestos exposure. This paper describes demographic, geographic, and occupational distributions of mesothelioma mortality in the United States, 1999-2001. The data (n = 7,524) were obtained from the National Center for Health Statistics multiple-cause-of-death records. Mortality rates (per million per year) were age-adjusted to the 2000 U.S. standard population, and proportionate mortality ratios (PMRs) were calculated by occupation and industry, and adjusted for age, sex, and race. The overall age-adjusted mortality rate was 11.52, with males (22.34) showing a sixfold higher rate than females (3.94). Geographic distribution of mesothelioma mortality is predominantly coastal. Occupations with significantly elevated PMRs included plumbers/pipefitters and mechanical engineers. Industries with significantly elevated PMRs included ship and boat building and repairing, and industrial and miscellaneous chemicals. These surveillance findings can be useful in generating hypotheses and developing strategies to prevent mesothelioma.

Berman, D. W., et al. (2012). "More on the dynamics of dust generation: the effects of mixing and sanding chrysotile, calcium carbonate, and other components on the characteristics of joint-compound dusts." Ann Occup Hyg 56(7): 852-867.

An ongoing research effort designed to reconstruct the character of historical exposures associated with use of chrysotile-containing joint compounds naturally raised questions concerning how the character (e.g. particle size distributions) of dusts generated from use of recreated materials compares to dusts from similar materials manufactured historically. This also provided an opportunity to further explore the relative degree that the characteristics of dusts generated from a bulk material are mediated by the properties of the bulk material versus the mechanical processes applied to the bulk material by which the dust is generated. In the current study, the characteristics of dusts generated from a recreated ready mix and recreated dry mix were compared to each other, to dusts from a historical dry mix, and to dusts from the commercial chrysotile fiber (JM 7RF3) used in the recreated materials. The effect of sanding on the character of dusts generated from these materials was also explored. Dusts from the dry materials studied were generated and captured for analysis in a dust generator-elutriator. The recreated and historical joint compounds were also prepared, applied to

drywall, and sanded inside sealed bags so that the particles produced from sanding could be introduced into the elutriator and captured for analysis. Comparisons of fiber size distributions in dusts from these materials suggest that dust from commercial fiber is different from dusts generated from the joint compounds, which are mixtures, and the differences persist whether the materials are sanded or not. Differences were also observed between sanded recreated ready mix and either the recreated dry mix or a historical dry mix, again whether sanded or not. In all cases, however, such differences disappeared when variances obtained from surrogate data were used to better represent the 'irreducible variation' of these materials. Even using the smaller study-specific variances, no differences were observed between the recreated dry mix and the historical dry mix, indicating that chrysotile-containing joint compounds can be recreated using historical formulations such that the characteristics of the modern material reasonably mimic those of a corresponding historical material. Similarly, no significant differences were observed between dusts from sanded and unsanded versions of similar materials, suggesting (as in previous studies) that the characteristics of asbestos-containing dusts are mediated primarily by the properties of the bulk material from which they are derived.

Boelter, F. W., et al. (2017). "A Bayesian Model and Stochastic Exposure (Dose) Estimation for Relative Exposure Risk Comparison Involving Asbestos-Containing Dropped Ceiling Panel Installation and Maintenance Tasks." Risk Anal.

Assessing exposures to hazards in order to characterize risk is at the core of occupational hygiene. Our study examined dropped ceiling systems commonly used in schools and commercial buildings and lay-in ceiling panels that may have contained asbestos prior to the mid to late 1970s. However, most ceiling panels and tiles do not contain asbestos. Since asbestos risk relates to dose, we estimated the distribution of eight-hour TWA concentrations and one-year exposures (a one-year dose equivalent) to asbestos fibers (asbestos f/cc-years) for five groups of workers who may encounter dropped ceilings: specialists, generalists, maintenance workers, nonprofessional do-it-yourself (DIY) persons, and other tradespersons who are bystanders to ceiling work. Concentration data (asbestos f/cc) were obtained through two exposure assessment studies in the field and one chamber study. Bayesian and stochastic models were applied to estimate distributions of eight-hour TWAs and annual exposures (dose). The eight-hour TWAs for all work categories were below current and historic occupational exposure limits (OELs). Exposures to asbestos fibers from dropped ceiling work would be categorized as "highly controlled" for maintenance workers and "well controlled" for remaining work categories, according to the American Industrial Hygiene Association exposure control rating system. Annual exposures (dose) were found to be greatest for specialists, followed by maintenance workers, generalists, bystanders, and DIY. On a comparative basis, modeled dose and thus risk from dropped ceilings for all work categories were orders of magnitude lower than published exposures for other sources of banned friable asbestos-containing building material commonly encountered in construction trades.

Brorby, G. P., et al. (2011). "Potential artifacts associated with historical preparation of joint compound samples and reported airborne asbestos concentrations." J Occup Environ Hyg 8(5): 271-278.

Airborne samples collected in the 1970s for drywall workers using asbestos-containing joint compounds were likely prepared and analyzed according to National Institute of Occupational Safety and Health Method P&CAM 239, the historical precursor to current Method 7400. Experimentation with a re-created, chrysotile-containing, carbonate-based joint compound suggested that analysis following sample preparation by the historical vs. current method produces different fiber counts, likely because of an interaction between the different clearing and mounting chemicals used and the carbonate-based joint compound matrix. Differences were also observed during analysis using Method 7402, depending on whether acetic acid/dimethylformamide or acetone was used during preparation to collapse the filter. Specifically, air samples of sanded chrysotile-containing joint compound prepared by the historical method yielded fiber counts significantly greater (average of 1.7-fold, 95% confidence interval: 1.5- to 2.0-fold) than those obtained by the current method. In addition, air samples prepared by Method 7402 using acetic acid/dimethylformamide yielded fiber counts that were greater (2.8-fold, 95% confidence interval: 2.5- to 3.2-fold) than those prepared by this method using acetone. These results indicated (1) there is an interaction between Method P&CAM 239 preparation chemicals and the carbonate-based joint compound matrix that reveals fibers that were previously bound in the matrix, and (2) the same appeared to be true for Method 7402 preparation chemicals acetic acid/dimethylformamide. This difference in fiber counts is the opposite of what has been reported historically for samples of relatively pure chrysotile dusts prepared using the same chemicals. This preparation artifact should be considered when interpreting historical air samples for drywall workers prepared by Method P&CAM 239.

Brorby, G. P., et al. (2008). "Re-creation of historical chrysotile-containing joint compounds." Inhal Toxicol 20(11): 1043-1053.

Chrysotile-containing joint compound was commonly used in construction of residential and commercial buildings through the mid 1970s; however, these products have not been manufactured in the United States for more than 30 years. Little is known about actual human exposures to chrysotile fibers that may have resulted from use of chrysotile-containing joint compounds, because few exposure and no health-effects studies have been conducted specifically with these products. Because limited amounts of historical joint compounds are available (and the stability or representativeness of aged products is suspect), it is currently impossible to conduct meaningful studies to better understand the nature and magnitude of potential exposures to chrysotile that may have been associated with historical use of these products. Therefore, to support specific exposure and toxicology research activities, two types of chrysotile-containing joint compounds were produced according to original formulations from the late 1960s. To the extent possible, ingredients were the same as those used originally, with many obtained from the original suppliers. The chrysotile used historically in these products was primarily Grade 7RF9 from the Philip Carey mine. Because this mine is closed, a suitable alternate was identified by comparing the sizes and mineral composition of asbestos structures in a sample of what has been represented to be historical joint compound (all of which were chrysotile) to those in samples of three currently commercially available Grade 7 chrysotile products. The re-created materials generally conformed to original product specifications (e.g. viscosity, workability, crack resistance), indicating that these materials are sufficiently representative of the original products to support research activities.

Centers for Disease, C. and Prevention (2009). "Malignant mesothelioma mortality--United States, 1999-2005." MMWR Morb Mortal Wkly Rep 58(15): 393-396.

Malignant mesothelioma is a fatal cancer primarily associated with exposure to asbestos. The latency period between first exposure to asbestos and clinical disease usually is 20--40 years. Although asbestos is no longer mined in the United States, the mineral is still imported, and a substantial amount of asbestos remaining in buildings eventually will be removed, either during remediation or demolition. Currently, an estimated 1.3 million construction and general industry workers potentially are being exposed to asbestos. To characterize mortality attributed to mesothelioma, CDC's National Institute for Occupational Safety and Health (NIOSH) analyzed annual multiple-cause-of-death records for 1999--2005, the most recent years for which complete data are available. For those years, a total of 18,068 deaths of persons with malignant mesothelioma were reported, increasing from 2,482 deaths in 1999 to 2,704 in 2005, but the annual death rate was stable (14.1 per million in 1999 and 14.0 in 2005). Maintenance, renovation, or demolition activities that might disturb asbestos should be performed with precautions that sufficiently prevent exposures for workers and the public. In addition, physicians should document the occupational history of all suspected and confirmed mesothelioma cases.

Dahlgren, J. and T. Peckham (2012). "Mesothelioma associated with use of drywall joint compound: a case series and review of literature." Int J Occup Environ Health 18(4): 337-343.

BACKGROUND: Drywall joint compound contained asbestos fibers, primarily chrysotile, in the 1950s through the 1970s. Workers in a variety of construction trades and homeowners were exposed to respirable asbestos from the use of these products, including during handling, mixing, sanding, and sweeping. Disturbance of in-place asbestos-containing joint compound continues to be a potential source of exposure during demolition or repair of wallboard. Studies from the 1970s and 1980s report air fiber measurements above current and historic regulatory limits during intended usage, and typical asbestos-related disease in drywall construction workers. OBJECTIVES: We present three cases of mesothelioma in which the only known exposure to asbestos was from joint compound and review the literature on exposure circumstances, dose and fiber types. CONCLUSIONS: Physicians treating mesothelioma patients should obtain a history of exposure to these products during work or home remodeling.

Dement, J., et al. (2009). "Mortality among sheet metal workers participating in a medical screening program." Am J Ind Med 52(8): 603-613.

BACKGROUND: The Sheet Metal Occupational Health Institute Trust (SMOHIT) was formed in 1985 to examine the health hazards of the sheet metal industry in the U.S. and Canada through an asbestos disease screening program. A study of mortality patterns among screening program participants was undertaken. METHODS: A cohort of 17,345 individuals with 20 or more years in the trade and who participated in the asbestos disease screening program were followed for vital status and causes of death between 1986 and 2004. Data from the screening program included chest X-ray results by International Labour Office (ILO) criteria and smoking history. Standardized mortality ratios (SMRs) by cause were generated using U.S. death rates and Cox proportional hazards models were used to investigate lung cancer risk relative to chest X-ray changes while controlling for smoking. RESULTS: A significantly reduced SMR of 0.83 (95% CI = 0.80-0.85) was observed for all causes combined. Statistically significant excess mortality was observed for pleural cancers, mesothelioma, and asbestosis in the SMR analyses. Both lung cancer and COPD SMRs increased consistently and strongly with increasing ILO profusion score. In Cox models, which controlled for smoking, increased lung cancer risk was observed among workers with ILO scores of 0/1 (RR = 1.17, 95% CI = 0.89-1.54), with a strong trend for increasing lung cancer risk with increasing ILO profusion score >0/0. CONCLUSIONS: Sheet metal workers are at increased risk for asbestos-related diseases. This study contributes to the literature demonstrating asbestos-related diseases among workers with largely indirect exposures and supports an increased lung cancer risk among workers with low ILO profusion scores.

Dement, J. M., et al. (2009). "Mortality of older construction and craft workers employed at Department of Energy (DOE) nuclear sites." Am J Ind Med 52(9): 671-682.

BACKGROUND: The U.S. Department of Energy (DOE) established medical screening programs at the Hanford Nuclear Reservation, Oak Ridge Reservation, the Savannah River Site, and the Amchitka site starting in 1996. Workers participating in these programs have been followed to determine their vital status and mortality experience through December 31, 2004. METHODS: A cohort of 8,976 former construction workers from Hanford, Savannah River, Oak Ridge, and Amchitka was followed using the National Death Index through December 31, 2004, to ascertain vital status and causes of death. Cause-

specific standardized mortality ratios (SMRs) were calculated based on US death rates. RESULTS: Six hundred and seventy-four deaths occurred in this cohort and overall mortality was slightly less than expected (SMR = 0.93, 95% CI = 0.86-1.01), indicating a "healthy worker effect." However, significantly excess mortality was observed for all cancers (SMR = 1.28, 95% CI = 1.13-1.45), lung cancer (SMR = 1.54, 95% CI = 1.24-1.87), mesothelioma (SMR = 5.93, 95% CI = 2.56-11.68), and asbestosis (SMR = 33.89, 95% CI = 18.03-57.95). Non-Hodgkin's lymphoma was in excess at Oak Ridge and multiple myeloma was in excess at Hanford. Chronic obstructive pulmonary disease (COPD) was significantly elevated among workers at the Savannah River Site (SMR = 1.92, 95% CI = 1.02-3.29). CONCLUSIONS: DOE construction workers at these four sites were found to have significantly excess risk for combined cancer sites included in the Department of Labor' Energy Employees Occupational Illness Compensation Program (EEOCIPA). Asbestos-related cancers were significantly elevated.

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.

Donovan, E. P., et al. (2012). "Evaluation of take home (para-occupational) exposure to asbestos and disease: a review of the literature." Crit Rev Toxicol 42(9): 703-731.

The potential for para-occupational (or "take-home") exposure to a number of chemicals has been recognized for over 60 years. We conducted a literature review in order to characterize reported cases of asbestos-related disease among household contacts of workers occupationally exposed to asbestos. Over 200 published articles were evaluated. Nearly 60 articles described cases of asbestos-related disease thought to be caused by para-occupational exposure. Over 65% of these cases were in persons who lived with workers classified as miners, shipyard workers, insulators, or others involved in the manufacturing of asbestos-containing products, with nearly all remaining workers identified as craftsmen. 98% of the available lung samples of the persons with diseases indicated the presence of amphibole asbestos. Eight studies provided airborne asbestos concentrations during (i) handling of clothing contaminated with asbestos during insulation work or simulated use of friction products; (ii) ambient conditions in the homes of asbestos miners; and (iii) wearing previously contaminated clothing. This review indicates that the literature is dominated by case reports, the majority of which involved household contacts of workers in industries characterized, generally, by high exposures to amphiboles or mixed mineral types. The available data do not implicate chrysotile as a significant cause of disease for household contacts. Also, our analysis indicates that there is insufficient information in the published literature that would allow one to relate airborne asbestos concentrations in a workplace to those that would be generated from subsequent handling of contact with clothing that had been contaminated in that environment. Ideally, a simulation study could be conducted in the future to better understand the relationships between the airborne concentrations in the workplace and the fiber characteristics that influence retention on fabric, as well as the concentrations that can be generated by handling the contaminated clothing by the persons in the home.

Hashim, D., et al. (2015). "Baseline serum β-carotene concentration and mortality among long-term asbestos-exposed insulators." Cancer Epidemiol Biomarkers Prev 24(3): 555-560.

Background: Although interventional trials demonstrated that moderate-dose β-carotene supplementation increases lung cancer mortality in smokers and asbestos-exposed workers, differences in serum concentrations in absence of supplementation have not been studied in asbestos-exposed workers. Methods: A mortality analysis was performed to assess the relationship of nonsupplemented serum β-carotene to all-cause and cancer mortalities using 1981 to 1983 serum β-carotene concentration measurements from 2,646 U.S. white male insulators (mean age, 57.7 years). Multivariable-adjusted Cox proportional hazard models that included terms for age, duration of asbestos exposure, smoking, season, and region were fitted to estimate mortality HRs and 95% confidence intervals (CI) according to serum β-carotene concentrations. Results: Median follow-up was 12.8 years and 984 (33.8%) subjects died during the follow-up period, including 415 deaths from overall cancer and 219 deaths from lung cancer. The overall mortality HR for a serum β-carotene increase of 10 μg/dL was 0.97 (95% CI, 0.96-0.99). Compared with the lowest quartile, HRs were 0.90 (95% CI, 0.76-1.07) for the second (38-65 μg/dL), 0.80 (95% CI, 0.67-0.96) for the third (66-104 μg/dL), and 0.63 (95% CI, 0.51-0.77) for the highest serum β-carotene quartile (≥105 μg/dL). There was no association between serum β-carotene and overall cancer mortality (HR, 1.00; 95% CI, 0.97-1.02) or lung cancer mortality (HR, 0.99; 95% CI, 0.96-1.02). Conclusions: Higher nonsupplemented serum β-carotene concentrations were negatively associated with all-cause mortality among asbestos-exposed individuals. Impact: Serum β-carotene can be a marker of one or more determinants of reduced mortality in asbestos-exposed workers. © 2014 AACR.

Hesterberg, T. W., et al. (2012). "Product stewardship and science: safe manufacture and use of fiber glass." Regul Toxicol Pharmacol 62(2): 257-277.

This paper describes a proactive product stewardship program for glass fibers. That effort included epidemiological studies of workers, establishment of stringent workplace exposure limits, liaison with customers on safe use of products and, most importantly, a research program to evaluate the safety of existing glass fiber products and guide development of new even safer products. Chronic inhalation exposure bioassays were conducted with rodents and hamsters. Amosite and crocidolite asbestos produced respiratory tract cancers as did exposure to "biopersistent" synthetic vitreous fibers. "less biopersistent" glass fibers did not cause respiratory tract cancers. Corollary studies demonstrated the role of slow fiber dissolution rates and biopersistence in cancer induction. These results guided development of safer glass fiber products and have been used in Europe to regulate fibers and by IARC and NTP in classifying fibers. IARC concluded special purpose fibers and refractory ceramic fibers are "possibly carcinogenic to humans" and insulation glass wool, continuous glass filament, rock wool and slag wool are "not classifiable as to their carcinogenicity to human." The NTP's 12th report on carcinogens lists "Certain Glass Wool Fibers (Inhalable)" as "reasonably anticipated to be a human carcinogen." "Certain" in the descriptor refers to "biopersistent" glass fibers and excludes "less biopersistent" glass fibers.

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.

Lange, J. H. (2004). "Asbestos abatement of pipe and floor tile/mastic and comparison of critical plastic barrier controls." Bull Environ Contam Toxicol 72(3): 542-546.

MATERIALS AND METHODS Personal samples were collected from the breathing zone of workers during abatement of pipe insulation and floor tile/mastic. Abatement was conducted in an exhibition facility located in Pennsylvania, USA.

Lange, J. H. (2005). "Airborne exposure during asbestos abatement of floor tile, wall plaster, and pipe insulation." Bull Environ Contam Toxicol 74(1): 70-72.

This study reports on personal exposure measurements during removal of asbestos-containing floor tile, wall plaster, and pipe insulation.

Lange, J. H. (2006). "Type and amount of asbestos in floor tile and mastic." Bull Environ Contam Toxicol 77(6): 807-809.

This investigation reports on the percent and form of asbestos in floor tile and mastic.

Lange, J. H., et al. (2006). "Smoking and alcohol use in asbestos abatement workers." Bull Environ Contam Toxicol 77(3): 338-342.

Studies have suggested that this occupational population has a high smoking rate compared to the general population. This preliminary investigation collected data on smoking and alcohol use for asbestos abatement workers attending training classes.

Lange, J. H., et al. (2012). "Infectious disease risk in asbestos abatement workers." BMC Public Health 12: 665.

BACKGROUND: The current literature reports increased infectious disease occurrence in various construction occupations, as an important contributor to morbidity and mortality arising from employment.These observations should be expanded to asbestos abatement workers, as the abatement can create an environment favorable for bacterial, viral and fungal infections. DISCUSSION: Asbestos abatement work employs activities resulting in cuts, blisters and abrasions to the skin, work in a dirty environment and exposure to dust, mists and fumes. Furthermore, this population exhibits a high smoking rate which increases the risk of chronic obstructive pulmonary disease and respiratory infections. In addition, these workers also commonly employ respirators, which can accumulate dirt and debris magnifying exposure to microbes. Use of respirators and related types of personal protective equipment, especially if shared and in the close environment experienced by workers, may enhance communicability of these agents, including viruses. SUMMARY: Abatement workers need to be provided with information on hazards and targeted by appropriate health education to reduce the infection risk. Epidemiological studies to investigate this risk in asbestos removers are recommended.

Lange, J. H., et al. (2006). "Asbestos abatement in a location previously improperly abated." Bull Environ Contam Toxicol 77(5): 723-725.

Exposure assessment during abatement of an area only partially abated previously.

Lange, J. H., et al. (2006). "Exposure to airborne asbestos during abatement of ceiling material, window caulking, floor tile, and roofing material." Bull Environ Contam Toxicol 77(5): 718-722.
Exposure assessment for airborne asbestos during abatement of ceiling material, window caulking, floor tile, and roofing material.

Lange, J. H., et al. (2008). "Exposure to airborne asbestos during abatement of ceiling material, window caulking, floor tile and roofing material." Bull Environ Contam Toxicol 80(1): 10-13.
Assessment of exposures to airborne asbestos during abatement of ceiling material, window caulking, floor tile and roofing material.

Lange, J. H., et al. (2006). "Personal airborne asbestos exposure levels associated with various types of abatement." Bull Environ Contam Toxicol 76(3): 389-391.
Personal airborne asbestos exposure levels associated with various types of abatement. Air samples collected during abatement projects in various US Schools.

Lange, J. H., et al. (2005). "Personal exposure during abatement of various asbestos-containing materials in the same work area." Bull Environ Contam Toxicol 74(6): 1034-1036.
Exposure assessment during periods where more than one ACM and/or type of asbestos were being abated in a shared work area.

Lange, J. H., et al. (2005). "Area and personal exposure measurements during asbestos abatement of a crawl space and boiler room." Bull Environ Contam Toxicol 74(2): 388-390.
Area and personal exposure measurements during asbestos abatement of a crawl space and boiler room.

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.

Lehman, E. J., et al. (2008). "Proportionate mortality study of the United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry." Am J Ind Med 51(12): 950-963.

BACKGROUND: This study examined causes of deaths among unionized plumbers, pipefitters and allied trades. METHODS: Deaths of union members from the years 1971, 1979, 1987, and 1995 were selected as a representative sample from a computer file provided by the union. These years provided 15,411 deaths for proportionate mortality ratio (PMR) analysis. RESULTS: PMRs for lung cancer and asbestosis were significantly elevated compared to U.S. white males. PMRs for chronic disease of the endocardium and cardiomyopathy were also elevated. Elevations were not observed in other a priori causes: laryngeal cancer, lymphatic cancer, and neurological disorders. PMRs for transportation accidents for pipe/steam-fitters were elevated in 1971 and 1979, but not in 1987 or 1995. CONCLUSION: Despite the limitations of a PMR analysis, study results indicate mortality related to asbestos exposure is, and will continue to be, an area of concern for members of the union.

Makie, T., et al. (2005). "Pulmonary abnormalities associated with occupational exposures at the Savannah River Site." Am J Ind Med 48(5): 365-372.

BACKGROUND: A program of medical evaluation for former Savannah River Site (SRS) workers at health effects due to exposures to hazardous or radioactive agents was conducted. METHODS: This study includes data from 1,368 participants aged 45 years or older who were assessed regarding work-history and exposures to industrial agents. According to the standard industrial classification (SIC), participants were employed in five of the SIC divisions. Based on the International Labour Office Classification of Radiographs, two categories of pleural and parenchymal abnormalities were evaluated by a single radiologist. The SRS results were compared with the second national health and nutrition examination survey (NHANES II) results. RESULTS: The odds ratio of the SRS male aged 45-75 compared to NHANES was 2.4 for pleura abnormalities and 0.8 for parenchymal abnormalities. Using logistic regression, the highest-risk worker division was construction (OR = 2.76); asbestos exposure was clearly associated with pleural abnormality (OR = 2.15). CONCLUSIONS: Pulmonary abnormalities were higher in former SRS workers than that in general population. Asbestos and possibly other exposures were related to pulmonary disease in this population.

Markowitz, S. B., et al. (2013). "Asbestos, asbestosis, smoking, and lung cancer: New findings from the north american insulator cohort." American Journal of Respiratory and Critical Care Medicine 188(1): 90-96.

Rationale: Asbestos, smoking, and asbestosis increase lung cancer risk in incompletely elucidated ways. Smoking cessation among asbestos-exposed cohorts has been little studied. Objectives: To measure the contributions of asbestos exposure, asbestosis, smoking, and their interactions to lung cancer risk in an asbestos-exposed cohort and to describe their reduction in lung cancer risk when they stop smoking. Methods: We examined lung cancer mortality obtained through the NationalDeath Index for 1981 to 2008 for 2,377maleNorth American insulators forwhomchest X-ray, spirometric, occupational, and smoking datawere collected in 1981 to 1983 and for 54,243 non-asbestosexposed blue collarmale workers fromCancer Prevention Study II for whom occupational and smoking data were collected in 1982. Measurements andMain Results: Lung cancer caused 339 (19%) insulator deaths. Lung cancer mortalitywas increasedby asbestos exposure alone among nonsmokers (rate ratio = 3.6 [95% confidence interval (CI), 1.7-7.6]), by asbestosis among nonsmokers (rate ratio=7.40 [95%CI, 4.0-13.7]), and by smoking without asbestos exposure (rate ratio = 10.3 [95% CI, 8.8-12.2]). The joint effect of smoking and asbestos alone was additive (rate ratio = 14.4 [95% CI, 10.7-19.4]) and with asbestosis, supra-additive (rate ratio=36.8 [95%CI, 30.1-45.0]). Insulator lung cancer mortality halved within 10 years of smoking cessation and converged with that of never-smokers 30 years after smoking cessation. Conclusions: Asbestos increases lung cancer mortality among

nonsmokers. Asbestosis further increases the lung cancer risk and, considered jointly with smoking, has a supra-additive effect. Insulators benefit greatly by quitting smoking.

Mowat, F., et al. (2005). "Occupational exposure to airborne asbestos from phenolic molding material (Bakelite) during sanding, drilling, and related activities." J Occup Environ Hyg 2(10): 497-507.

In this study, a historical phenolic (Bakelite) molding material, BMMA-5353, was tested to determine the airborne concentrations of asbestos fibers released during four different activities (sawing, sanding, drilling, and cleanup of dust generated from these activities). Each activity was performed for 30 min, often in triplicate. The primary objective for testing BMMA-5353 was to quantitatively determine the airborne concentration of asbestos fibers, if any, in the breathing zone of workers. Uses of this product typically did not include sawing or sanding, but it may have been drilled occasionally. For this reason, only small quantities were sawed, sanded, and drilled in this simulation study. Personal (n = 40), area (n = 80), and background/clearance (n = 88) air samples were collected during each activity and analyzed for total fiber concentrations using phase contrast microscopy (PCM) and, for asbestos fiber counts, transmission electron microscopy (TEM). The raw PCM-total fiber concentrations were adjusted based on TEM analyses that reported the fraction of asbestos fibers, to derive a PCM-asbestos concentration that would enable calculation of an 8-hour time-weighted average (TWA). The estimated 8-hour TWAs ranged from 0.006 to 0.08 fibers per cubic centimeter using a variety of worker exposure scenarios. Therefore, assuming an exposure scenario in which a worker uses power tools to cut and sand products molded from BMMA-5353 and similar products in the manner evaluated in this study, airborne asbestos concentrations should not exceed current or historical occupational exposure limits.

Mowat, F., et al. (2007). "Simulation tests to assess occupational exposure to airborne asbestos from asphalt-based roofing products." Ann Occup Hyg 51(5): 451-462.

This study sought to evaluate exposure from specific products to evaluate potential risk from roof repair activities. Five asbestos-containing fibered roof coatings and plastic cements, representing a broad range of these types of products, were tested in exposure simulations. These products were applied to representative roof substrates. Release of asbestos fibers during application and sanding of the product shortly thereafter (wet sanding) were tested initially. Other roof substrates were cured to simulate a product that had been on a rooftop for several months and then were tested to evaluate release of fibers during hand sanding and hand scraping activities. Additional tests were also conducted to evaluate asbestos release during product removal from tools and clothing. Two personal (n = 84) and background/clearance (n = 49) samples were collected during each 30-min test and analyzed for total fiber concentration [phase-contrast microscopy (PCM)] and for asbestos fiber count [transmission electron microscopy (TEM)]. PCM concentrations ranged from <0.005 to 0.032 fibers per cubic centimeter (f cc(-1)). Chrysotile fibers were detected in 28 of 84 personal samples collected. TEM concentrations ranged from <0.0021 to 0.056 f cc(-1). Calculated 8-h time-weighted averages (TWAs) ranged from 0.0003 to 0.002 f cc(-1) and were comparable to the background TWA concentration of 0.0002 f cc(-1) measured in this study. Based on these results, it is unlikely that roofers were exposed to airborne asbestos concentrations above the current or historical occupational guidelines during scraping and sanding of these products during roof repair.

Mundt, D. J., et al. (2009). "A review of changes in composition of hot mix asphalt in the United States." J Occup Environ Hyg 6(11): 714-725.

This review researched the materials, methods, and practices in the hot mix asphalt industry that might impact future exposure assessments and epidemiologic research on road paving workers. Since World War II, the U.S. interstate highway system, increased traffic volume, transportation

speeds, and vehicle axle loads have necessitated an increase in demand for hot mix asphalt for road construction and maintenance, while requiring a consistent road paving product that meets state-specific physical performance specifications. We reviewed typical practices in hot mix asphalt paving in the United States to understand the extent to which materials are and have been added to hot mix asphalt to meet specifications and how changes in practices and technology could affect evaluation of worker exposures for future research. Historical documents were reviewed, and industry experts from 16 states were interviewed to obtain relevant information on industry practices. Participants from all states reported additive use, with most being less than 2% by weight. Crumb rubber and recycled asphalt pavement were added in concentrations approximately 10% per unit weight of the mix. The most frequently added materials included polymers and anti-stripping agents. Crumb rubber, sulfur, asbestos, roofing shingles, slag, or fly ash have been used in limited amounts for short periods of time or in limited geographic areas. No state reported using coal tar as an additive to hot mix asphalt or as a binder alternative in hot mix pavements for high-volume road construction. Coal tar may be present in recycled asphalt pavement from historical use, which would need to be considered in future exposure assessments of pavers. Changes in hot mix asphalt production and laydown emission control equipment have been universally implemented over time as the technology has become available to reduce potential worker exposures. This work is a companion review to a study undertaken in the petroleum refining sector that investigated current and historical use of additives in producing petroleum-derived asphalt cements.

Paustenbach, D. J., et al. (2004). "Occupational exposure to airborne asbestos from coatings, mastics, and adhesives." J Expo Anal Environ Epidemiol 14(3): 234-244.

Over the past few years, a question has arisen about the degree of exposure to airborne asbestos associated with the application, cleanup, and tear-out of glues and mastics used between 1940 and the present. These liquid products were used either to adhere insulation to pipes and boilers or to cover the insulation so as to protect it. In this study, four asbestos-containing products, a coating, two mastics, and an adhesive, which were representative of the various classes of products that have been used historically, were tested to determine the airborne concentration of asbestos fibers released during five different activities (application, spill cleanup, sanding, removal, and sweep cleaning). Each activity was performed for 30 min (often in triplicate). Personal (n=172) and area (n=280) air samples were collected during the tests, and each was analyzed for total fiber concentrations using phase contrast microscopy (PCM), and for asbestos fiber count using transmission electron microscopy (TEM). A measurable concentration of asbestos fibers was detected in six of the 452 samples collected (0.0017-0.0184 fibers/ml). The observed asbestos fibers counts for each product were similar to background. Only one asbestos fiber was detected in an indoor background sample; no asbestos fibers were identified in any of the outdoor background samples. The (raw) PCM-total fiber concentrations were adjusted based on TEM analyses that reported fraction of asbestos fibers (to derive a PCM-asbestos concentration) and by the fraction of the 8-h workday that a worker spends performing the activity (to derive a calculated TWA). For the coatings, mastics, and adhesives evaluated in the present study, the calculated TWAs using hypothetical work scenarios were well below the current Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) of 0.1 fibers/ml. The calculated TWAs ranged from 0.03 to 0.009 fibers/ml. The actual concentration of airborne asbestos due to these products is almost certainly much less than the TWAs, and may be so low as to not be measurable. These results support the historical view that these products, over the past 50 years, did not pose an occupational health hazard under foreseeable uses.

Perkins, R. A., et al. (2007). "Asbestos release from whole-building demolition of buildings with asbestos-containing material." J Occup Environ Hyg 4(12): 889-894.

The whole-building demolition method, which entails one-or two-story buildings pushed down by heavy equipment, loaded into trucks, and hauled away, is generally the most cost-effective means to remove small buildings. For taller buildings, a crane and wrecking ball may be used initially to reduce the height of the building. Demolitions might release asbestos fibers from friable asbestos-containing material (ACM). Fibers also might be released from nominally nonfriable ACM (Categories I and II nonfriable ACM) if it becomes friable after rough handling throughout the whole-building demolition process. This paper reports on asbestos air monitoring from two demolition projects involving ACM. In one building, Category II nonfriable ACM was present because it could not be removed safely prior to demolition. Both projects had large quantities of gypsum wallboard with ACM joint compound and ACM flooring. One building had large quantities of ACM spray-on ceiling material. During the demolitions personal air monitoring of the workers and area air monitoring downwind and around the sites were conducted. The monitoring found the concentrations of fibers detected by phase contrast microscopy were generally well below the permissible exposure limits (PEL) of workers. Electron microcopy analysis of samples at or near the PEL indicated most of the fibers were not asbestos, and the actual asbestos exposure was often below the detection limit of the procedure. The buildings were kept wet with fire hoses during the demolition and that required large quantities of water, 20,000-60,000 gal/day (75-225 m(3)/day). Earlier studies found little asbestos release from buildings containing only nonfriable ACM demolished by this method. This project found a negligible release of asbestos fibers, despite the presence of nonfriable materials that might become friable, such as ACM joint compound and spray-on ACM ceiling coating.

Perkins, R. A., et al. (2008). "Evaluation of public and worker exposure due to naturally occurring asbestos in gravel discovered during a road construction project." J Occup Environ Hyg 5(9): 609-616.

During a repair and reconstruction project of an unpaved highway in a remote region of Alaska, workers discovered, after construction had commenced, that the materials used from a local material site contained asbestos (variously described as tremolite or actinolite). The regional geology indicated the presence of ultramafic rock, which often contains asbestos. Evaluation of asbestos exposure to workers, their equipment, and living quarters was required, as was the possible future exposure of workers and the general public to asbestos already used in the roadway construction. In addition, a decision was needed on whether to use materials from the contaminated site in the future. Of the almost 700 breathing zone air monitoring samples taken of the workers, 3% of the samples indicated exposures at or near 0.1 f/cc by the National Institute for Occupational Safety and Health (NIOSH) 7400 phase contrast microscopy (PCM) procedure. Thirty-six of the PCM samples underwent transmission electron microscopy (TEM) analysis by the NIOSH 7402 procedure, which indicated that about 40% of the fibers were asbestos. After classifying samples by tasks performed by workers, analysis indicated that workers, such as road grader operators who ground or spread materials, had the highest exposures. Also, monitoring results indicated motorist exposure to be much less than 0.1 f/cc. The design phase of any proposed construction project in regions that contain ultramafic rock must consider the possibility of amphibole contamination of roadway materials, and budget for exploration and asbestos analysis of likely materials sites.

Phelka, A. D. and B. L. Finley (2012). "Potential health hazards associated with exposures to asbestos-containing drywall accessory products: A state-of-the-science assessment." Crit Rev Toxicol 42(1): 1-27.

Until the late 1970s, chrysotile asbestos was an ingredient in most industrial and consumer drywall accessory products manufactured in the US. In 1977, the Consumer Product Safety Commission (CPSC) issued a ban of consumer patching compounds containing "respirable, free-form asbestos" based on their prediction of exceptionally high rates of asbestos-related diseases among individuals using patching compounds for as little as a few days. Although hundreds of thousands of workers and

homeowners handling these products may have experienced exposure to asbestos prior to the ban, there has been no systematic effort to summarize and interpret the information relevant to the potential health effects of such exposures. In this analysis, we provide a comprehensive review and analysis of the scientific studies assessing fiber type and dimension, toxicological and epidemiological endpoints, and airborne fiber concentrations associated with joint compound use. We conclude that: 1) asbestos in drywall accessory products was primarily short fiber (< 5 microm) chrysotile, 2) asbestos in inhaled joint compound particulate is probably not biopersistent in the lung, 3) estimated cumulative chrysotile exposures experienced by workers and homeowners are below levels known to be associated with respiratory disease, and 4) mortality studies of drywall installers have not demonstrated a significantly increased incidence of death attributable to any asbestos-related disease. Consequently, contrary to the predictions of the CPSC, the current weight of evidence does not indicate any clear health risks associated with the use of asbestos-containing drywall accessory products. We also describe information gaps and suggest possible areas of future research.

Platner, J. (2002). "Industrial hygiene at the World Trade Center disaster." Appl Occup Environ Hyg 17(2): 84-85.

Column on worker exposures at the WTC site

Racine, W. P. (2010). "Emissions concerns during renovation in the healthcare setting: asbestos abatement of floor tile and mastic in medical facilities." J Environ Manage 91(7): 1429-1436.

Healthcare facilities undergoing renovation have specific concerns that are exacerbated when the restoration requires asbestos abatement of aged floor tile and mastic. The current state of the art for removal of these materials involves manual removal of floor tile and chemical stripping of mastic. Utilization of these stripping chemicals is a concern for facilities whose perception is based on a safe, caring, and healthy environment. In this study, wet grinding is evaluated as an alternative to chemical stripping of asbestos-containing floor tile mastic. This study endeavors to answer the question; what is the difference between these two methodologies in terms of their operational efficacy and suitability in the healthcare setting. Wet grinding and chemical stripping are evaluated in a side-by-side comparison using a mixed methods approach. The data shows that the methodologies are statistically similar in terms of their cost and emissions data. The data indicates that the benefits associated with the wet grinding method offer advantages that are not present using the chemical stripping method. This study also demonstrates that wet grinding is a viable alternative to chemical stripping especially in healthcare facilities.

Rice, C. and E. F. Heineman (2003). "An asbestos job exposure matrix to characterize fiber type, length, and relative exposure intensity." J Occup Environ Hyg 18(7): 506-512.

The relationship between asbestos exposure and disease has been well documented, although questions persist as to variation in risk by the type and length of fiber. For a series of jobs with potential asbestos exposure, the primary fiber type (e.g., amosite, anthophylite, chrysotile, crocidolite, or tremolite) and fiber length were identified and the relative exposure intensity was estimated. The resulting job exposure matrix may be useful in epidemiological studies where asbestos is an exposure of interest.

Ringen, K., et al. (2015). "Mortality of older construction and craft workers employed at department of energy (DOE) nuclear sites: Follow-up through 2011." Am J Ind Med 58(2): 152-167.

Background: The Building Trades National Medical Screening Program (BTMed) was established in 1996 to provide occupational medicine screening examinations for construction workers who have worked at US Department of Energy nuclear sites. Workers participating in BTMed between

1998 and 2011 were followed to determine their vital status and mortality experience through December 31, 2011. Methods: The cohort includes 18,803 BTMed participants and 2,801 deaths. Cause-specific Standardized Mortality Ratios (SMRs) were calculated based on US death rates. Results: Mortality was elevated for all causes, all cancers, cancers of the trachea, bronchus, and lung and lymphatic and hematopoietic system, mesothelioma, COPD, and asbestosis. Conclusions: Construction workers employed at DOE sites have a significantly increased risk for occupational illnesses. Risks are associated with employment during all time periods covered including after 1980. The cancer risks closely match the cancers identified for DOE compensation from radiation exposures. Continued medical surveillance is important. © 2014 Wiley Periodicals, Inc.

Rosen, J., et al. (2015). "National institute of environmental health sciences worker training program: Perspectives on the health and safety of workers, volunteers, and residents involved in the cleanup and rebuilding of New York City housing damaged by hurricane sandy." Environmental Justice 8(3): 105-109.

Hurricane Sandy damaged or destroyed 76,000 buildings with over 300,000 housing units; nine percent of the total housing in New York City. Sandy also damaged 405 New York City Housing Authority (NYCHA) buildings, affecting 35,000 units. Affected residents were forced to move in with family, temporary housing, or endured long periods without heat or electricity, as most building systems were located in flooded basements. Additionally, workers, volunteers, and residents who engaged in cleanup were potentially exposed to raw sewage, mold, asbestos, lead, dust, carbon monoxide, as well as electrocution; slips, trips, and falls; and construction-related safety hazards. Stress and trauma were also significant. These exposures may cause death, disease, and injury. The need to provide protection programs and effective training crosses a number of populations including day laborers, volunteer groups, and residents who are involved in cleanup and rebuilding. The National Institute of Environmental Health Sciences (NIEHS) Worker Education and Training Program (WETP) has provided funding to more than 20 grantees including universities, labor unions, and other organizations to provide effective worker health and safety and disaster preparedness and response training for more than 20 years. This has built a critical infrastructure in the targeted industrial sectors and unions. WETP has also been active in disasters including September 11, Katrina, the Gulf oil spill, and Sandy. Preventing injury and disease in all the groups that are involved in disaster response, cleanup, and rebuilding warrants extending the NIEHS health and safety programs to volunteers, residents, and worker populations who previously have not had access to hazardous materials and related training programs. This can be accomplished by adapting health and safety programs and just-in-time training to the needs and cultures of these groups. These efforts should also further ongoing approaches to empower grantees and end-users so that they can independently build dynamic health and safety and training programs into their disaster preparedness and response work. © Mary Ann Liebert, Inc. 2015.

Ross, R. M. (2003). "The clinical diagnosis of asbestosis in this century requires more than a chest radiograph." Chest 124(3): 1120-1128.

Asbestosis can cause significant impairment and even death. It is also a well-recognized risk factor for the development of lung cancer. However, asbestosis is usually diagnosed on clinical grounds without the aid of pathology. Many physicians and researchers believe that in asbestos-exposed individuals with adequate latency, chest radiographic findings that are compatible with asbestosis are sufficient for the diagnosis. In order to determine whether this approach is reasonable, the positive predictive value of the chest radiograph for the diagnosis of pathologic asbestosis must be determined. This requires information about the prevalence of asbestosis, and the sensitivity and specificity of the chest radiograph in its diagnosis. In this article, the sensitivity and specificity of the chest radiograph in diagnosing asbestosis is determined from a literature analysis. The prevalence of asbestosis among present-day cohorts, such as construction workers and petrochemical workers, is assessed based on the relative risk of lung cancer in patients with asbestosis and the overall relative risk of lung cancer in these occupationally asbestos-exposed cohorts. The results indicate a positive predictive value for abnormal chest radiograph findings alone to be significantly < 50%. Therefore, the chest radiograph is inadequate as the sole clinical tool to be used to diagnose asbestosis in these cohorts. However, when rales and a low diffusing capacity of the lung for carbon monoxide are also present, the diagnosis of asbestosis on clinical grounds can be made with reasonable confidence.

Roter, D. L., et al. (2006). "Worker produced health education material for the construction trades." Int Q Community Health Educ 27(3): 231-243.

There is broad acceptance of the philosophic foundations of health education as grounded in the collaborative model of client and professional partnership. In practice. however, this partnership is largely dominated by the professional side. Workers may be particularly sensitive to professional domination as issues associated with health promotion vs. safety and health programs at the workplace are often politicized. This polarization is particularly evident in the area of asbestos-related hazard prevention, reduction, and education. Using asbestos hazards as the unifying theme, we participated in a program to facilitate active participation of workers in the production of their own occupational health education materials through the use of the photonovel. Representatives from some seven building trade locals worked with a staff to produce a twenty-four-page photonovel for their co-workers. A random sample of 500 members of building trades locals received either a copy of the photonovel or a popular NCI asbestos pamphlet with an evaluation questionnaire. Differences between the groups were evident in favor of the photonovel in readability, factual recall, general credibility, and attitudes toward future involvement in health and safety issues.

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.

Sheehan, P., et al. (2010). "Simulation tests to assess occupational exposure to airborne asbestos from artificially weathered asphalt-based roofing products." Ann Occup Hyg 54(8): 880-892.

Historically, asbestos-containing roof cements and coatings were widely used for patching and repairing leaks. Although fiber releases from these materials when newly applied have been studied, there are virtually no useful data on airborne asbestos fiber concentrations associated with the repair or removal of weathered roof coatings and cements, as most studies involve complete tear-out of old roofs, rather than only limited removal of the roof coating or cement during a repair job. This study was undertaken to estimate potential chrysotile asbestos fiber exposures specific to these types of roofing products following artificially enhanced weathering. Roof panels coated with plastic roof cement and fibered roof coating were subjected to intense solar radiation and daily simulated precipitation events for 1 year and then scraped to remove the weathered materials to assess chrysotile fiber release and potential worker exposures. Analysis of measured fiber concentrations for hand scraping of the weathered products showed 8-h time-weighted average concentrations that were well below the current Occupational Safety and Health Administration permissible exposure limit for asbestos. There was, however, visibly more dust and a few more fibers collected during the hand scraping of weathered products compared to the cured products previously tested. There was a notable difference between fibers released from weathered and cured roofing products. In weathered samples, a large fraction of chrysotile fibers contained low concentrations of or essentially no magnesium and did not meet the spectral, mineralogical, or morphological definitions of chrysotile asbestos. The extent of magnesium leaching from chrysotile fibers is of interest because several researchers have reported that magnesium-depleted chrysotile fibers are less toxic and produce fewer mesothelial tumors in animal studies than normal chrysotile fibers.

Sheehan, P. J., et al. (2011). "Chamber for testing asbestos-containing products: validation and testing of a re-created chrysotile-containing joint compound." Ann Occup Hyg 55(7): 797-809.

Joint compound products containing chrysotile asbestos were commonly used for building construction from the late 1940s through the mid-1970s. Few relevant data exist to support reconstructing historical worker exposures to fibers generated by working with this material. Therefore, we re-created 1960s-era chrysotile-containing joint compound (JCC) and compared its characteristics to a current-day asbestos-free joint compound (JCN). Validation studies showed that a bench-scale chamber with controlled flow dynamics, designed to quantify particulate emissions from joint compound products, provided precise and reliable measurements of generated airborne dust mass, chrysotile fiber concentrations, and corresponding activity-specific emission rates. Subsequent chamber studies characterized fibers counted by phase contrast microscopy (PCM) per mass of respirable dusts and total suspended particulate dusts (total dusts), generated during JCC sanding or sweeping, as well as corresponding dust emission rates for JCC and JCN, and the ratio of total to respirable dust mass for JCN. From these data we estimated factors, F(CH-rd) and F(CH-td) (in units of f cm(-3) per mg m(-3)), by which respirable JCN dust mass concentrations collected during construction use can be converted to corresponding airborne PCM fiber concentrations generated by sanding or sweeping JCC. For sanding, median values (95% confidence limits) of F(CH-rd) and F(CH-td) were estimated to be 0.044 (0.039-0.050) and 0.212 (0.115-0.390) f cm(-3) per mg m(-3), respectively. The F(CH-td) to F(CH-rd) ratio indicates that approximately five times as many airborne PCM fibers are anticipated per unit air volume sampled when JCC dust is collected on cassettes (as done historically), than when respirable JCC dust is collected on cyclones. As the sizes of individual fibers collected appear to be primarily respirable, this difference may be a sampling artifact and suggests caution in interpreting historical fiber concentration measures made using cassettes during work with JCC-like materials. F(CH-rd) can be used with published and newly generated field measurements of respirable dust mass concentrations associated with the use of JCN or equivalent JCN materials to better characterize historical worker exposures to PCM fibers from use of JCC or equivalent JCCs. The experimental process described also can be used to develop conversion factors for other combinations of modern-day asbestos-free and historical chrysotile-containing products.

Silverstein, M. A., et al. (2009). "Developments in asbestos cancer risk assessment." Am J Ind Med 52(11): 850-858.

BACKGROUND: Efforts have been made for 25 years to develop asbestos risk assessments that provide valid information about workplace and community cancer risks. Mathematical models have

been applied to a group of workplace epidemiology studies to describe the relationships between exposure and risk. EPA's most recent proposed method was presented at a public meeting in July 2008. METHODS: Risk assessments prepared by USEPA, OSHA, and NIOSH since 1972 were reviewed, along with related literature. RESULTS AND CONCLUSIONS: None of the efforts to use statistical models to characterize relative cancer potencies for asbestos fiber types and sizes have been able to overcome limitations of the exposure data. Resulting uncertainties have been so great that these estimates should not be used to drive occupational and environmental health policy. The EPA has now rejected and discontinued work on its proposed methods for estimating potency factors. Future efforts will require new methods and more precise and reliable exposure assessments. However, while there may be genuine need for such work, a more pressing priority with regard to the six regulated forms of asbestos and other asbestiform fibers is to ban their production and use.

Welch, L., et al. (2015). "Mortality among sheet metal workers participating in a respiratory screening program." Am J Ind Med 58(4): 378-391.

BACKGROUND: The Sheet Metal Occupational Health Institute Trust (SMOHIT) established a screening program in 1985 to examine the health hazards of the sheet metal industry in the U.S. and Canada. METHODS: 17,345 individuals with over 20 years in the trade and who participated in the program were followed for causes of death between 1986 and 2010. Both SMRs and Cox proportional hazards models investigated predictors of death due to lung cancer, mesothelioma, and chronic obstructive pulmonary disease (COPD). RESULTS: Significant excess mortality was seen for mesothelioma and asbestosis. Controlling for smoking, a strong trend for increasing lung cancer risk with increasing chest x-ray profusion >0/0 was observed. With an profusion score <1/0, FEV1 /FVC <80% was associated with lung cancer risk. COPD risk increased with increasing profusion score. CONCLUSIONS: This study demonstrates asbestos-related diseases among workers with largely indirect exposures and an increased lung cancer risk with low ILO scores.

Welch, L. S. and E. Haile (2009). "Asbestos-related disease among sheet metal workers 1986-2004: radiographic changes over time." Am J Ind Med 52(7): 519-525.

BACKGROUND: In 1985, the Sheet Metal Workers International Association and the Sheet Metal and Air Conditioning National Association formed The Sheet Metal Occupational Health Institute Trust (SMOHIT) to examine the health hazards of the sheet metal industry. Between 1986 and 2004 18,211 individuals were examined. At the time of the first examination 9.6% of all participants (1,745) had findings consistent with parenchymal disease (ILO > 1/0), and 21% (3,827) had pleural scarring. METHODS: 2181-Two thousand hundred eighty-one who had no radiographic evidence of pneumoconiosis on baseline examination underwent a second examination. RESULTS: By the second examination, 5.3% had developed parenchymal disease on chest radiograph; an additional 12.4% had developed pleural scarring without parenchymal disease. Factors that predicted new cases of pneumoconiosis on radiograph were the calendar year the worker entered the sheet metal trade, smoking, and shipyard work. Forty-seven percent of those smoking at the time of initial exam reported having quit smoking by the second examination. CONCLUSIONS: Asbestosis is still occurring 50 years after first exposure. Exposed workers benefit from medical screening programs that incorporate smoking cessation.

Welch, L. S., et al. (2007). "Change in prevalence of asbestos-related disease among sheet metal workers 1986 to 2004." Chest 131(3): 863-869.

In 1985, the Sheet Metal Workers International Association and the Sheet Metal and Air Conditioning National Association formed The Sheet Metal Occupational Health Institute Trust to examine the health hazards of the sheet metal industry in the United States and Canada. Between

1986 and 2004, 18,211 individuals were examined. The mean age of this cohort was 57.9 years, and the participants had worked for a mean (+/- SD) duration of 32.9 +/- 6 years in the sheet metal trade. Twenty-three percent of participants were current smokers, 49% were former smokers, and 28% were never-smokers. A total of 9.6% of participants (1,745 participants) had findings that were consistent with parenchymal disease (International Labor Organization [ILO] score, >/= 1/0); 60% of those with an ILO score >/= 1/0 were classified as 1/0, 34% as 1/1 to 1/2, and 6% as >/= 2/1. A total of 21% of participants (3,827 participants) had pleural scarring. There was a lower prevalence of nonmalignant asbestos-related disease among those who began to work after 1970, when compared to workers who began to work before 1949; those who began to work between 1950 and 1969 had a prevalence between the other two groups. The strongest predictor of both parenchymal and pleural disease on a chest radiograph was the calendar year in which the worker began sheet metal work; work in a shipyard was also an important risk. The results of this study suggest that the efforts to reduce asbestos exposure in the 1980s through strengthened Occupational Safety and Health Administration regulation have had a positive public health impact.

Williams, P., et al. (2007). "Retrospective exposure assessment of airborne asbestos related to skilled craftsmen at a petroleum refinery in Beaumont, Texas (1940-2006)." J Toxicol Environ Health A 70(13): 1076-1107.

Despite efforts over the past 50 or more years to estimate airborne dust or fiber concentrations for specific job tasks within different industries, there have been no known attempts to reconstruct historical asbestos exposures for the many types of trades employed in various nonmanufacturing settings. In this paper, 8-h time-weighted average (TWA) asbestos exposures were estimated for 12 different crafts from the 1940s to the present day at a large petroleum refinery in Beaumont, TX. The crafts evaluated were insulators, pipefitters, boilermakers, masons, welders, sheet-metal workers, millwrights, electricians, carpenters, painters, laborers, and maintenance workers. This analysis quantitatively accounts for (1) the historical use of asbestos-containing materials at the refinery, (2) the typical workday of the different crafts and specific opportunities for exposure to asbestos, (3) industrial hygiene asbestos air monitoring data collected at this refinery and similar facilities since the early 1970s, (4) published and unpublished data sets on task-specific dust or fiber concentrations encountered in various industrial settings since the late 1930s, and (5) the evolution of respirator use and other workplace practices that occurred as the hazards of asbestos became better understood over time. Due to limited air monitoring data for most crafts, 8-h TWA fiber concentrations were calculated only for insulators, while all other crafts were estimated to have experienced 8-h TWA fiber concentrations at some fraction of that experienced by insulators. A probabilistic (Monte Carlo) model was used to account for potential variability in the various data sets and the uncertainty in our knowledge of selected input parameters used to estimate exposure. Significant reliance was also placed on our collective professional experiences working in the fields of industrial hygiene, exposure assessment, and process engineering over the last 40 yr. Insulators at this refinery were estimated to have experienced 50th (and 95th) percentile 8-h TWA asbestos exposures (which incorporated 8-h TWA fiber concentrations, respirator use and effectiveness, and time spent working with asbestos-containing materials) of 9 (16) fibers/cc (cubic centimeter) from 1940 to 1950, 8 (13) fibers/cc from 1951 to 1965, 2 (5) fibers/cc from 1966 to 1971, 0.3 (0.5) fibers/cc from 1972 to 1975, and 0.005 (0.02) fibers/cc from 1976 to 1985 (estimated exposures were <0.001 fibers/cc after 1985). Estimated 8-h TWA exposures for all other crafts were at least 50- to 100-fold less than that of insulators, with the exception of laborers, whose estimated 8-h TWA exposures were approximately one-fifth to one-tenth of those of insulators. In spite of the data gaps, the available evidence indicates that our estimates of 8-h TWA asbestos exposures reasonably characterize the typical range of values for these categories of workers over time.

Williams, P. R., et al. (2007). "A review of historical exposures to asbestos among skilled craftsmen (1940-2006)." J Toxicol Environ Health B Crit Rev 10(5): 319-377.

This article provides a review and synthesis of the published and selected unpublished literature on historical asbestos exposures among skilled craftsmen in various nonshipyard and shipyard settings. The specific crafts evaluated were insulators, pipefitters, boilermakers, masons, welders, sheet-metal workers, millwrights, electricians, carpenters, painters, laborers, maintenance workers, and abatement workers. Over 50 documents were identified and summarized. Sufficient information was available to quantitatively characterize historical asbestos exposures for the most highly exposed workers (insulators), even though data were lacking for some job tasks or time periods. Average airborne fiber concentrations collected for the duration of the task and/or the entire work shift were found to range from about 2 to 10 fibers per cubic centimeter (cm3 or cc) during activities performed by insulators in various nonshipyard settings from the late 1960s and early 1970s. Higher exposure levels were observed for this craft during the 1940s to 1950s, when dust counts were converted from millions of particles per cubic foot (mppcf) to units of fibers per cubic centimeter (fibers/cc) using a 1:6 conversion factor. Similar tasks performed in U.S. shipyards yielded average fiber concentrations about two-fold greater, likely due to inadequate ventilation and confined work environments; however, excessively high exposure levels were reported in some British Naval shipyards due to the spraying of asbestos. Improved industrial hygiene practices initiated in the early to mid-1970s were found to reduce average fiber concentrations for insulator tasks approximately two- to five-fold. For most other crafts, average fiber concentrations were found to typically range from <0.01 to 1 fibers/cc (depending on the task or time period), with higher concentrations observed during the use of powered tools, the mixing or sanding of drywall cement, and the cleanup of asbestos insulation or lagging materials. The available evidence suggests that although many historical measurements exceeded the current OSHA 8-h time-weighted average (TWA) permissible exposure limit (PEL) of 0.1 fibers/cc, average fiber concentrations generally did not exceed historical occupational exposure limits in place at the time, except perhaps during ripout activities or the spraying of asbestos in enclosed spaces or onboard ships. Additionally, reported fiber concentrations may not have represented daily or actual human exposures to asbestos, since few samples were collected beyond specific short-term tasks and workers sometimes wore respiratory protective equipment. The available data were not sufficient to determine whether the airborne fiber concentrations represented serpentine or amphibole asbestos fibers, which would have a pronounced impact on the potential health hazards posed by the asbestos. Despite a number of limitations associated with the available air sampling data, the information should provide guidance for reconstructing asbestos exposures for different crafts in specific occupational settings where asbestos was present during the 1940 to 2006 time period.