

sented with an opportunity to assist in the evaluation of cellulose insulation (CI) by conducting an exposure assessment of CI applicators through an interagency agreement with the National Institute of Environmental Health Sciences/NTP. NIOSH completed the study by evaluating 10 contractors in various geographic locations across the United States.

**Methods:** During each contractor site visit, air samples were collected for total dust, respirable dust, and for scanning electron microscopy (SEM) analysis to characterize any fibers in the dust. The CI installer and hopper operator each had two SEM air samples collected for each day of CI activities. Bulk samples were collected and analyzed for metals, boron, and sulfate content. Real-time and video exposure monitoring were also conducted to further characterize the CI dust and workers' exposures.

**Results and Conclusions:** Employees in virtually all CI application activities were exposed to total dust levels which exceeded the OSHA PEL, 8-hour TWA of 15 mg/m<sup>3</sup>. Air sampling results indicated low levels of respirable dust. The SEM analyses identified fibers with an average length of 28 micrometers (µm) and ranging from 5 to 150 µm. Statistical analysis revealed that area and CI installer, total dust air sample concentrations in the attic were significantly higher when applying the CI dry than wet (geometric mean concentration for CI installer, dry was 74.8 mg/m<sup>3</sup> versus wet at 18.7 mg/m<sup>3</sup>;  $p < 0.01$ ). Exposure concentrations vary significantly between employees when involved with dry CI related activities ( $p < 0.01$ ). Respirable dust air sample concentrations vary significantly between sampling areas when collected during dry CI related activities ( $p = 0.03$ ). Based on the air sample data, NIOSH investigators conclude that there is a potential health hazard from exposure to CI and recommends that employees involved with CI activities wear at a minimum NIOSH approved particulate filtering respirators with a N95 designation.

## 269

**AN AUTOMOBILE RACING TEAM'S OCCUPATIONAL EXPOSURE TO POTENTIALLY OTOTOXIC CHEMICALS.** K. Gwin, K. Wallingford, L. Van Campen, T. Morata, NIOSH, Cincinnati, OH.

**BACKGROUND:** Because of significant noise exposure during automobile racing, NIOSH partnered with a performance enhancement consulting firm and a stock car racing team to conduct a pilot study evaluating occupational exposure to potentially ototoxic chemicals. The purpose of the study was to evaluate the possibility of noise and chemical interaction that could lead to occupational hearing loss. **METHODS:** Exposure assessments were conducted at the team's garage and at one daytime and one nighttime race at a short (0.5 mile) oval track during the 2000 racing season. (This track represents a "worst case" exposure scenario due to its small size, steep banking, and high grandstand configuration.) Both area and personal air samples were collected for selected volatile organic compounds (VOCs), metals, and carbon monoxide (CO). Air samples for VOCs were obtained using both thermal desorption and charcoal tubes for qualitative and quantitative determination, respectively; air samples for metals were obtained on mixed cellulose ester membrane filters; and CO concentrations were measured using direct-reading, data-logging dosimeters. **RESULTS:** Airborne concentrations of VOCs and metals were either not detected or were extremely low, well below any relevant occupational exposure criteria. Mean CO concentrations ranged from <1 to 6 ppm

at the team's garage, 12 to 14 ppm during the daytime race, and 3 to 139 ppm during the nighttime race. Peak CO levels ranged from 6 to 117 ppm at the team's garage, 31 to 55 ppm during the daytime race, and 26 to 835 ppm during the nighttime race. **CONCLUSIONS:** These data suggest that CO concentrations may exceed current 15-minute and 8-hour time-weighted average occupational exposure criteria during automobile racing practice and qualifying events. However, the determination of percent carboxyhemoglobin in exhaled breath after racing events to evaluate the actual CO body burden for the driver and crewmembers of the racing team will be necessary to confirm these environmental data.

## 270

**AN EXPOSURE EVALUATION OF LEAD FROM WAVE SOLDERING OPERATIONS DURING THE MANUFACTURE OF CIRCUIT BOARDS.** B. King, NIOSH, Cincinnati, OH.

**Background:** NIOSH conducted a health hazard evaluation (HHE) in response to an employee request concerning potential lead exposure at a circuit board production facility. At this facility, a 60% tin/40% lead solder is used in wave solder machines to secure electronic components to the wafer boards. In particular, two processes of concern were identified. One, a daily process, was the skimming of the surface of the liquid solder in the solder pot with a slotted spoon, removing any surface dross. A second, weekly process was the thorough cleaning of internal wave solder machine components and a deep cleaning of dross from the liquid solder. **Methods:** Personal breathing zone and area air samples were collected for airborne lead on individuals working at the wave solder machines, at various stations of the production lines, and throughout the facility. Surface wipe sampling for lead was performed on surfaces including equipment, floors, lunchroom tabletops, and ventilation registers. Wipe samples were also performed on the hands of individuals working with the lead solder after their normal hygiene practices. **Results:** All personal breathing zone and area air samples returned results well below all applicable evaluation criteria. However, surface wipe sampling results ranged from below the analytic limit of detection to a high of 1700 µg lead per wipe sample. Results from hand wipe sampling revealed a high of 52 µg lead per wipe sample, taken from the individual after normal hand-washing who performed the deep cleaning of the solder pot. **Conclusion:** Although exposure to lead via inhalation appears to be low, its ingestion is still very possible due to the presence of lead found on a variety of work surfaces. NIOSH investigators recommended increased house-keeping procedures for better removal of lead from work surfaces, improved personal hygiene procedures, and vigilance in the use of proper personal protective equipment and engineering controls.

## 271

**OCCUPATIONAL EXPOSURES IN SEISMIC RETROFITTING OPERATIONS.** J. McKernan, G. Piacitelli, K. Roegner, L. Delaney, NIOSH, Cincinnati, OH; G. Bayne, UC Berkeley/OEHS, Berkeley, CA.

Seismic retrofitting is the process of re-engineering existing structures to limit the extent of damage caused by earthquakes. Workers employed as general and special trade contractors as well as laborers and helpers are engaged in retrofitting operations. This industry is positioned to increase in size due to governmental funding available for natural hazard

mitigation in states with frequent seismic activity, such as Alaska and California. This research project quantitatively characterized full-shift personal exposures to diesel exhaust (measured as elemental carbon), lead, respirable dusts, respirable quartz and noise hazards associated with retrofitting operations. Chemical assessments were performed using NIOSH sampling and analytical methods, and noise assessments utilized commercially available noise dosimeters calibrated in accordance with NIOSH REL sampling criteria. A total of 57 personal samples were collected for 11 occupations and 20 tasks observed over three days on a single work site. Participating occupations included: excavators, bricklayers, carpenters, concrete chippers, construction yard workers, core-drillers, demolition laborers, foremen, iron workers, rebar installers, and welders. Personal sampling results indicate that respirable dust (N=23) exposures ranged up to 9.17 mg/m<sup>3</sup>, with demolition laborers having the highest exposures. Respirable quartz results (N=23) ranged up to 0.53 mg/m<sup>3</sup>, with demolition laborers and concrete chippers having the greatest exposures. Noise dosimetry results (N=19) ranged from 76-112 dBA, with excessive exposures (>100 dBA) being attributed to tasks performed by concrete chippers, demolition laborers, and iron workers. Lead exposures (N=15) ranged from 0.002 to 0.069 mg/m<sup>3</sup>, with concrete chippers having the highest exposures. Exposure to diesel exhaust (N=7) ranged up to 0.04 mg/m<sup>3</sup>, with highest results being attributed to excavation tasks. Fifty-three percent of the results were equivalent to, or exceeded applicable occupational exposure criteria. Sampling results show that particulate and noise abatement controls are necessary for the occupations indicated as having the highest exposures within this unique industry.

## 272

**CONTROLLING RESPIRABLE QUARTZ DUST IN SAND-BLASTING: ROLE OF SAND PARTICLE SIZE AND A DUST SUPPRESSION AGENT.** J. Nelson, S. Soderholm, M. Greskevitch, CDC/NIOSH, Morgantown, WV.

Abrasive blasting with sand can generate high concentrations of respirable quartz dust to which workers can be exposed. Overexposure to such dust can lead to the development of silicosis, a potentially deadly lung disease. Abrasive blasting is prevalent in construction, automotive, and shipbuilding industries and is often used for cleaning. The process involves using high-pressure air to blast abrasive media against the surface to be cleaned. The impact against a hard surface causes the particles to fracture. If the particles are small enough, they can become airborne dust, easily spread by the air pressure generated by the abrasive blaster. Data from a previously described abrasive blasting laboratory study were analyzed to determine which experimental parameters correlated with lower respirable quartz dust concentrations. The blasting process was performed on 2-foot square steel plates with air samplers placed in locations around the testing area and on the operator. Some of the sands were treated with a commercial dust-suppressing agent. Analysis of the samples indicate that sands with initial larger particle sizes create higher levels of respirable quartz dust than sands with the lowest particle sizes (average particle size by sieve analysis <0.45 mm). The dust suppressant appears more effective in reducing respirable quartz concentrations when used on sands with the lowest initial particle sizes (>50% reduction). Sands with smaller initial particle sizes have similar consumption rates and cleaning rates when compared to those with larger initial particle sizes. According to the

hierarchy of controls, substituting a less toxic material for sand in abrasive blasting should be considered. However, if sand is to be used, these data suggest that respirable quartz airborne concentrations might be reduced without sacrificing cleaning rate or increasing sand consumption by selecting abrasive sands with small initial particle sizes and adding a commercial dust suppressant.

## 273

**CONTROL OF EXPOSURES TO CRYSTALLINE SILICA IN STONE MONUMENT MANUFACTURING.** R. Kurimo, L. Blade, H. William, NIOSH, Cincinnati, OH.

National Institute for Occupational Safety and Health (NIOSH) researchers conducted a field survey at a small manufacturer of stone monuments (mainly cemetery markers) to characterize workers' exposures to respirable crystalline silica and to evaluate exposure control methods. These exposures result from the use of abrasive blasting for engraving and texturing, since the abrasive agent and/or the stone may contain crystalline silica. Partial-work-shift air sampling, covering three- to six-hour periods during which abrasive blasting was performed, revealed breathing zone concentrations between 19 and 43 micrograms of respirable crystalline silica per cubic meter of air ( $\mu\text{g}/\text{m}^3$ ), below the NIOSH recommended exposure limit (REL) of  $50 \mu\text{g}/\text{m}^3$ . However, since the abrasive blasting was done on a part-time basis with time allotted for preparatory tasks, and substantial portions of the sampling periods included these other tasks, full-shift exposures could be significantly greater at a similar facility where blasting is performed continuously. The primary engineering dust-control measure employed—a commercially available, exhausted, automated-blasting enclosure with a screened opening for viewing—was evaluated by measuring parameters such as face velocities (which were at least 160 feet per minute), using smoke tubes, and conducting real-time particulate monitoring synchronized with videotaping. The results revealed that this system effectively controlled the dust generated during automated blasting. The real-time video monitoring also revealed deficiencies in the operation, including the use of a compressed-air hose during cleanup, and an abrasive agent recycle chute that was not enclosed, substantially contributed to the measured exposures. Correction of these minor problems can maintain exposures below the NIOSH REL even if continuous blasting is conducted.

## 274

**OZONE EXPOSURES DURING A TREATMENT PROCESS OF RAW BEEF.** R. Hall, K. Martinez, K. Gwin, NIOSH, Cincinnati, OH.

NIOSH conducted a Health Hazard Evaluation (HHE) during an ozone research and development (R&D) sanitation treatment process of raw beef. Prior to the assessment, the company had conducted two R&D tests. During the first test, the workers did not use respiratory protection, and the ozone generator was shut down after approximately 15 minutes when workers reported respiratory symptoms (lung discomfort, nose and throat discomfort, and asthma attacks) and nausea. During the second test, workers wore half-mask air purifying respirators equipped with cartridges intended for ozone. The company monitored for ozone during the second test and reported concentrations of 0.2 parts of ozone per million parts of air (ppm). The workers did not report any symptoms during the second testing pro-

cedure which lasted approximately 2 hours. During the NIOSH HHE, workers and NIOSH representatives wore full face pressure-demand self-contained breathing apparatus to protect against ozone inhalation. During the NIOSH evaluation, peak ozone concentrations of 5 ppm (measured with detector tubes and a real-time monitor) were indicated near the inlet of the tumbler where a worker would occasionally insert raw beef products. Measurements collected with an ozone real-time monitor indicated average ozone concentrations ranging from 0.1 to 1 ppm in the general tumbler area with an 8-hour time-weighted average of 0.05 ppm. Ozone detector tube samples taken around the tumbler area during the testing procedures indicated concentrations ranging from 2 to 3 ppm. The measured peak ozone concentration of 5 ppm exceeds the NIOSH ceiling limit (0.1 ppm), and is at the NIOSH recommended immediately dangerous to life or health limit (5 ppm) for ozone. The eight-hour TWA is below the OSHA PEL, and is at the ACGIH® TLV® for exposure during heavy physical exertion. However, ozone peak concentrations exceeded excursion limits. Based on the NIOSH study, management personnel at the company have decided to discontinue the use of ozone to kill bacteria in beef products.

## 275

**AIRBORNE RESIN ACID EXPOSURES AMONG WORKERS AT A MAGAZINE PRINTING COMPANY.** C. Cook, E. Page, NIOSH, Cincinnati, OH.

Background: In September 1999, the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation at a magazine printing company to assess exposures to resin acids during lithography printing and bindery processes. Workers reported symptoms consistent with occupational contact dermatitis, respiratory irritation, and asthma. Inks used were complex chemical mixtures containing epoxy and phenolic resins. Printed paper materials were dried by ovens and bound using a hot-melt adhesive containing colophony (rosin). Resin acids are components in rosin that are responsible for dermal and respirable sensitization. Methods: An air sampling strategy was devised to measure resin acids released by heated inks and hot-melt adhesives. Thirteen personal breathing-zone (PBZ) and 11 area air samples for resin acids were collected on polytetrafluoroethylene (PTFE) filters using air sampling pumps calibrated at 2 liters per minute. Analysis was performed by a high-pressure liquid chromatography (HPLC) procedure for the analysis of resin acids, specifically abietic and dehydroabietic acids. Results: Full-shift PBZ air samples for resin acids collected on printing press operators and bindery operators revealed time-weighted average (TWA) concentrations up to 2 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) for dehydroabietic acid, while only trace abietic acid concentrations were measured. General area air sampling revealed concentrations up to  $4.5 \mu\text{g}/\text{m}^3$  for abietic acid and  $9.2 \mu\text{g}/\text{m}^3$  for dehydroabietic acid at printing presses, and up to  $6 \mu\text{g}/\text{m}^3$  for abietic acid and  $77 \mu\text{g}/\text{m}^3$  for dehydroabietic acid in the bindery department. Although there is no NIOSH recommended exposure limit (REL), the American Conference of Governmental Industrial Hygienists' (ACGIH) recommends reducing exposures to as low as possible. Conclusions: Workers were exposed to airborne resin acids generated by both the printing and bindery processes. While resin acids are known to derive from heated materials containing rosin, heated inks containing epoxy and phenolic resins were suspected of generating resin acids.

## 276

**MONITORING THE EFFECTIVENESS OF A CONTAINMENT DURING APPLICATION OF FLOOR COATINGS ADJACENT TO OCCUPIED AREAS.** T. Kapfer, T. Froehlig, L. Henckel, Institute for Environmental Assessment, Brooklyn Park, MN.

To prevent indoor air quality complaints in adjacent areas to a chemical floor coating project at a large metropolitan airport, a containment with exhaust ventilation was constructed to place the area under negative air pressure. Operations continued in the area adjacent to the 12,362 sq. ft. floor coating application area. This study evaluated the effectiveness of the containment and exhaust ventilation performance during floor preparation and application of three membrane coatings. Sampling was conducted primarily at times when the level of contaminants were expected to be highest and included: total airborne particulate samples during concrete floor repair and prep work; volatile organic compounds and isocyanate samples during and after the application of the chemical membrane coats; and  $\text{CO}_2$  and CO levels during most of the floor work. The highest contaminant levels detected inside of the containment included: airborne particulate levels of  $15 \text{ mg}/\text{m}^3$  and CO levels of 10 to 80 ppm during the floor prep work; and airborne toluene levels around 300 ppm during the application of the final coat. At all times, the containment maintained floor coating-related contaminants outside the containment at levels well below regulatory exposure limits. And, in most cases, levels outside the containment were at or near background levels measured prior to commencement of the project. Airflow measurements were also collected for the two exhaust fans serving the containment. Based on our observations and sampling results, the containment and temporary exhaust system were effective in preventing airborne contaminants from migrating to the surrounding occupied areas.

## 277

**EVALUATION OF BERYLLIUM SURFACE CONTAMINATION IN WORK AREAS WHERE FINISHED BERYLLIUM PARTS ARE HANDLED AND STORED.** G. Whitney, Los Alamos National Laboratory, Los Alamos, NM.

Non-destructive use and handling of finished beryllium parts ("articles") is not expected to result in exposure to airborne beryllium. However, concerns were raised that years of operations involving beryllium parts could have resulted in a build-up of beryllium contamination on work area surfaces. Los Alamos National Laboratory has a surface contamination limit of  $0.2 \mu\text{g}/100 \text{ cm}^2$  for "clean" work areas. To address these concerns swipe samples were collected in work areas where beryllium parts are handled and/or stored. This survey also helped to meet the beryllium inventory requirements of 29 CFR 850, Chronic Beryllium Disease Prevention Program. Surfaces most likely to be contaminated due to the nature of operations in the work areas (work benches, storage shelves, packaging materials, etc.) were swiped using paper filters wetted with distilled water. Beryllium parts were also swiped using dry linen circles. Samples were submitted to an on-site laboratory and analyzed by ICPEs. A total of 135 swipe samples were collected in 7 work areas. Results were separated into three categories: beryllium parts ( $n=15$ , mean =  $4.27 \mu\text{g}/100 \text{ cm}^2$ , 20% were  $< 0.2 \mu\text{g}/100 \text{ cm}^2$ ); beryllium packaging materials ( $n=27$ , mean =  $2.08 \mu\text{g}/100 \text{ cm}^2$ , 48% were  $< 0.2$

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