

sound level meter. The effect of using different engine, propeller and muffler configurations to reduce workshift noise exposures is evaluated using a Metrosonics Model db-3100 noise dosimeter. During normal herbicide application activities, the airboat engine and propeller, not the application equipment, is the primary source of noise. Sound pressure levels increase with increasing engine and propeller RPM. Measurements indicate that the wood propeller offers an engineering control advantage over the carbon fiber propeller by shifting its energy to a portion of the noise spectrum to which the ear is less sensitive. The research found the use of aircraft engines to offer an engineering control advantage over automotive engines because they provide maximal thrust at minimal engine RPM. The dosimetry tests reveal the daily noise exposures of aquatic herbicide applicators to vary between 94 and 106 dBA. Herbicide application and open plane activities contribute most of the daily noise dose. The use of earmuffs and earplugs is effective protection only when used in combination. It is therefore recommended that airboat operators and passengers wear both types of protection at all times.

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STUDY OF ACTIVE NOISE CONTROL IN AIR-CONDITIONING DUCTS. E. Omana, Universidad Central de Venezuela, Caracas, Venezuela; D. Dager, G. H. UCV, Caracas, Venezuela.

ABSTRACT For many years physicists have known that when acoustic waves are randomly mixed, the noise level can be increased or diminished. In 1934 the German Lueg realized that air velocity is less than the speed of electricity, so that when a sound wave is moving from A to B there is enough time inside an electric circuit to process signals and activate a response that will attenuate the noise at B. Lueg's original idea was to shoot the sound wave in B against the sound wave coming from A. Nowadays noise is a huge problem for office workers, and one of its causes is the movement of air through air-conditioning ducts. This type of noise is characterized by frequencies of under 2,000 cps, a level at which passive control is not efficient. We have managed to create an active noise control system that generates an inverse wave. The system is made up of an electrodynamic microphone, a wave inverter, an amplifier and a loudspeaker. Results: Noise levels were determined around two air-conditioning outlets before and after the installation of the active control system. In both outlets the noise level decreased in frequencies between 31.5 and 2,000 cps and increased in frequencies between 4,000 and 8,000 cps. In one of the outlets the total level of sound diminished from 63.8 to 59.8 dB(A) and in the other from 62.1 to 55.9 dB(A). Analysis of air velocity revealed that the microphone and loudspeaker installations did not perturb air movement. Conclusion: Noise generated by air-conditioning system in offices can be diminished applying active noise and workers inside them could have better work conditions.

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RADIATION LEAKAGE FROM MICROWAVE OVENS USED IN AN ACADEMIC INSTITUTION. F. Akbar-Khanzadeh, M. Jahangir-Blourchian, M. A. Valigosky, Medical College of Ohio, Toledo, OH; S. M. Mirbod, Gifu University School of Medicine, Gifu, Japan. An academic institution with numerous

microwave ovens in routine use never systematically inspected their operating condition nor checked for radiation leakage. Because employees were concerned about the possible risks associated with radiation exposure from ovens used in their workplace, a research survey was initiated to collect information on the ovens' characteristics and condition of operation. A microwave survey meter (Model HI-1801, Holaday Industries Inc.) was used to check the appliances for radiation leakage. Of the 112 appliances located in the institution, 77 were in common rooms, 30 in research laboratories, 3 in the cafeteria kitchen and 2 in clinics. Characteristics of the appliances included physical condition (excellent 14%, good 40%, average 37% and poor 9%), years of service (>10 years 29%, 6-10 years 35% and < 6 years 34%), total volume (average 58 L and range 20-152 L), compliance with 21 CFR Subchapter J (94%), operating power (120-2400 W), output power (500-1400 W), output frequency (2450 MHz 100%), functional interlock (98%), and interlock shut-off (temporary 14%, permanent 86%). At less than 5 cm, 76% of ovens showed no detectable radiation leakage, 21% showed leakage from 0.02-0.75 mW/cm², and 3% showed leakage from 0.75-2.5 mW/cm². Mean leakage for ovens in poor condition was 0.5 mW/cm² and for ovens in average or good condition was 0.1 mW/cm². None of the ovens in excellent condition showed leakage. The mean leakage for ovens used for >10 years was 0.2 mW/cm² and for others was 0.1 mW/cm². In conclusion, radiation leakage in 97% of ovens was less than 0.75 mW/cm², the amount of radiation leakage decreased as the years of service for the ovens decreased, and radiation leakage decreased if the ovens were kept in better physical condition.

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FACTORS RELATING TO OPERATOR EXPOSURE FROM PLASTIC WELDERS. J. Wright, Department of Employment, Training and Industrial Relations, Brisbane, Queensland, Australia.

In plastics manufacturing, radiofrequency electromagnetic energy at 15 to 50 MHz are used to make strong seams in dielectric material. Operators work close to the frequently unshielded die and field strengths to which operators are exposed can be extremely high. The audits were initiated after a WH&S pilot study in 1998-99 found high exposure levels and low levels of exposure awareness were common in the industry. Seven hygienists around Queensland conducted the measurements. Each audit consisted of field strength measurements taken with one of three Holaday Hi series broadband isotropic field strength meters. Measurement was conducted in 55 workplaces (129 operators). Field strength measurements were taken at the level of the eyes, chest, gonads, hands and ankles. The duty cycle was measured over six minutes and the temporal average calculated. Light measurements were taken at each operator position and health-related information was collected. The data were analysed. Exposure for electric, magnetic or both fields exceeded the Australian Exposure Limits for 10-400 MHz (E field 61 V/m, H field 0.16 A/m) in 78% of workplaces. Magnetic field exposure was significantly associated with welder type. In the previous year 26% of operators had received burns. Of the operators who had received recent burns 40% reported tingling in fingers when welding. The average magnetic field strength at the hands was 2.15 A/m where the operator had reported finger tingling when welding and 1.33 A/m where not. Exposure to the eyes averaged

0.501 A/m when illuminance exceeded 400 lux but 2.493 A/m when it did not. Distance, grounding, shielding, retro-redesign or a combination were used to reduce excessive field strengths. Exposure of dielectric welder operators was found to be excessive, particularly for the magnetic field and seems to be significantly associated with the induction of burns and nerve damage in the hands and/or wrists.

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ACTIVITIES OF THE NIOSH HAZARD EVALUATIONS AND TECHNICAL ASSISTANCE (HETA) PROGRAM. B. Reh, R. Hartle, NIOSH, Cincinnati, OH.

This poster summarizes the activities of the Hazard Evaluations and Technical Assistance (HETA) Program of the National Institute for Occupational Safety and Health (NIOSH). The HETA Program responds to requests from employers, employees, employee representatives, other Federal agencies, and State and local agencies. Through a staff of industrial hygienists, engineers, occupational physicians, epidemiologists, other health professionals, and support personnel, the HETA Program conducts health hazard evaluations (HHEs) to determine if chemical, physical, biological, or other agents are hazardous to workers. Control procedures, improved work practices, and medical programs may be recommended to reduce hazardous exposures and prevent adverse health effects. The results of individual evaluations may trigger wider studies of similar exposures in other settings, or may stimulate recommendations for implementation or modification of health standards. More than 10,000 evaluations have been completed since the inception of the HETA Program in 1972. Recently, the HETA Branch has begun to prepare internal annual reports, publish HHE summary documents, and develop an internal evaluation program. The annual reports present information about requests received and projects closed, personnel, and non-HHE activities. Over the past five years, HETAB has received an average of 350 HHE requests per year and closed an average of 340 HHEs per year. Of the requests received, approximately two-fifths have involved one or more site visits, two-fifths were closed with an informative letter, and one-fifth were legally invalid. The most common health effects reported on the requests were respiratory and neurologic, but not all requests reported symptoms. Of the projects involving site visits, 30 to 40 a year were closed within six months. Many HHEs have involved similar exposures or health effects and the HETA Program has started to publish summary documents for some of these, including tuberculosis, lead exposures, isocyanate exposures, firefighting, and wastewater treatment.

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NIOSH EXPOSURE ASSESSMENT OF CELLULOSE INSULATION APPLICATORS. R. McCleery, J. McCullough, R. Hall, J. Fernback, NIOSH, Cincinnati, OH.

Introduction: The National Institute for Occupational Safety and Health (NIOSH) was pre-

sented with an opportunity to assist in the evaluation of cellulose insulation (CI) by conducting an exposure assessment of CI applicators through an inter-agency 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/m³. 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/m³ versus wet at 18.7 mg/m³; $p < 0.01$). 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.

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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.

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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.

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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/m³, with demolition laborers having the highest exposures. Respirable quartz results (N=23) ranged up to 0.53 mg/m³, 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/m³, with concrete chippers having the highest exposures. Exposure to diesel exhaust (N=7) ranged up to 0.04 mg/m³, 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.

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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

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