## 227

DETECTION OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN SKIN WIPE SAMPLES OF AUTOMOTIVE MECHANIC TRAINEES. A. Booth-Jones, NIOSH, Cincinnati, OH; C. Neumeister, NIOSH, Cincinnati, OH; G. Talaska, University of Cincinnati, College of Medicine, Cincinnati, OH

Epidemiologic evidence suggests that automobile and truck mechanics are at increased risk of bladder cancer. For mechanics, used gasoline engine oil (UGEO) is a major occupational exposure. UGEOs contain polycyclic aromatic hydrocarbons (PAHs) formed during combustion in engine operation. Because these PAHs have low volatility, mechanics have potential dermal exposure. Many PAHs found in UGEO are known or probable carcinogens.

The purpose of this study was to determine whether PAHs were detected in skin wipe samples of automotive mechanic trainees. Sixty-nine participants were enrolled from vocational schools in Ohio and Kentucky. Participants completed an informed consent; 36 were included in the intervention group and were provided with training and special cleansers; and 33 were placed in the nonintervention group.

Skin wipe samples were collected by filter paper after participants massaged corn oil into their hands. Successive skin wipe samples were taken from those in the intervention group after the intervention was in place. Samples were extracted by ultrasonification in acetonitrile, filtered, and stored until analysis.

Sixteen model PAHs measured by fluorescence and UV detectors were naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene (FLUOR), pyrene, benz[a] anthracene (BAA), chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a] pyrene (BAP), dibenz[a,h] anthracene (DAHA), benzo[ghi]perylene, and indeno[1,2,3-cd]pyrene (INDENO).

Eighty-one percent of those in the intervention group provided at least two skin-wipe samples. Measurable amounts of PAHs were detected in 90% of the samples.

The concentrations of PAHs ranged from 54.51 µg/µL to 0.18 µg/µL for FLUOR, BAA, BaP, DAHA, and INDENO, which are carcinogens. Mean levels of BAP and DAHA were 4.63 µg/µL and 1.88 µg/µL, respectively; more than 13 participants had levels above these mean values.

This study shows that PAHs from UGEO are present in hand-wipe samples of automotive trainees. Excess PAH exposure is hazardous, and interventions should be designed to reduce contact.

## 228

PERSPECTIVES ON HUMAN EXPOSURE TO XENOBIOTICS. R. Earley, LabCorp, Burlington, NC

It is quite apparent today that the general population has many concerns about contact with any chemical substance. For example, there are media reports that readily illustrate this concern for xenobiotics (e.g., lead in paint, mercury in dental fillings, and pesticide levels in fish). To better focus these issues, a retrospective study of more than 35,000 biological monitoring results from a diverse population was compared with reference or literature criteria.

Analytical methods employed were inductively coupled plasma-mass spectrometry (ICP/MS), cold vapor atomic absorption spectrometry, and gas liquid chromatography. Determinants investigated were arsenic, cadmium, carbon monoxide, chlorinated pesticides, chromium, lead, mercury, PCB, phenol, selenium, and zinc protoporphrin.

An example of the data was blood lead, which was contrasted against a reference range, the ACGIH BEI®, and the OSHA lead standard. At the highest level of 40 mcg/dL, representing the OSHA lead standard, >95% of the studied population met the criterion. Even at lower levels of 30 mcg/dL (OSHA recommended level for men and women of childbearing years) and 20 mcg/dL (reference level), >90% of the population was within these specifications.

Mercury data exhibit similar characteristics to the blood lead population. The blood mercury reference range of <15 mcg/L encompassed >90% of the population, and the urine mercury range accommodated >95% of the data.

Looking at these determinants, it is plausible to conclude that while the population does come in contact with detectable levels of xenobiotics, the majority is within recognized reference intervals.

NOTE: The conclusions and opinions presented here are those of the author and do not necessarily reflect the views of Laboratory Corporation of America Holdings or its subsidiaries, including LabCorp.

## 229

HISTORICAL EXPOSURES DURING FIBER GLASS PRODUCT MANUFACTURING. T. Smith, Harvard School of Public Health, Boston, MA; M. Quinn, University of Massachusetts-Lowell, Lowell, MA; R. Stone, G. Marsh, University of Pittsburgh, Pittsburgh, PA

Extensive exposure and operational data have been collected from four primary producers of fiber glass products at 14 plant sites, as a part of an ongoing cancer morality study. The major products included glass filament rovings and textiles, blowing wool, batt and board insulation, and small-diameter filter media. Retrospective exposure estimates have been developed for all of the plants contributing subjects to the cohort.

This paper reports on the analysis of the exposure data provided by the companies and validated by the investigators. Extensive quality and comparability evaluation was necessary to deal with changes in methodology and changes in survey objectives (routine evaluation vs. complaint driven).

Exposure data were combined with detailed technical historical information to examine the quantitative effects of product, operational and job activities, weather, and temporal trends. As expected from earlier published data, there was a wide range of exposures associated with different product types: glass filament products with diameters >10 mm had the lowest average exposures (frequently, <0.001 f/cc), and small-diameter filter media (<1 mm) without binder or oil showed the highest mean exposures, at times exceeding 1 f/cc.

Production of similar products using the same production techniques led to similar average exposures. A strong effect of survey date was found by analysis of variance, which was associated with changes in production rate, product type, and season. A broad downward trend was seen going from the mid-1970s to 1990, which was associated with a variety of process changes and the installation of exposure controls.

Systematic differences, two-fold or more for the same job and work location, were observed in comparing means between industrial hygiene surveys at the same plant. This variation limits the confidence that can be achieved for estimates derived from sampling data from a single survey.

# Ventilation and Air Contaminant Control Papers 230-235

## 230

DEVELOPMENT OF A COMPUTATIONAL FLUID DYNAMICS MODEL OF WORKER EXPOSURE TO PARTICULATE MATTER DISPERSED IN A TIME-DEPENDENT AIRFLOW. J. Richmond-Bryant, M. Flynn, University of North Carolina, Chapel Hill, NC

Computational fluid dynamics (CFD) modeling of particulate transport in an indoor environment has the potential to be an economical method of assessing exposures over potentially large (i.e., room-size) domains without any physical intrusion to the work environment. Moreover, CFD modeling can become a cost-effective means for evaluating competing designs for particulate-capture ventilation hoods. However, development of a CFD model of aerosol transport is necessary before the model can be employed as a reliable tool for industrial hygiene applications.

In a typical industrial environment, low-turbulence airflow will induce periodic vortex shedding, which is believed to be a primary determinant of contaminant transport into a worker's breathing zone (BZ). For this reason, the authors combined a Lagrangian particle-tracking algorithm with a discrete vortex method (DVM) airflow model. The DVM was selected because it is well-suited for modeling time-dependent vortex shedding.

In the particle-tracking algorithm, a semianalytical form of the Newtonian drag equation is integrated numerically during each time-step. Preliminary simulations were performed for 1 mm, 10 mm, and 20 mm unit-density particles dispersed in an airflow of 0.246 m/s. Particles were released upstream of a 0.61 m diameter circular cylinder that represents the worker.

Results for the 10 mm and 20 mm simulations show that small numbers of particles will become entrained into the BZ, defined here as the region extending 0.14 m in front of the cylinder. In all cases, the particles followed the vortex clusters formed downstream of the worker.

In addition, 10 mm particles were released 0.15 m downstream of the cylinder. The particles in this case were observed traveling directly upstream and into the cylinder.

Computational effort was found to be inversely proportional to the size of the particle released.

## 231

CONTROL OF WAKE-INDUCED EXPOSURE USING AN INTERRUPTED OSCILLATING JET. J. Bennett, K. Crouch, S. Shulman, NIOSH/Division of Physical Sciences and Engineering, Cincinnati, OH

Ventilation design often involves ideas drawn from potential flow theory. However, in the downstream region of a worker's body, the flow is turbulent, making the concept that a contaminant will flow from high to low pressure problematic.

With an air contaminant source in the wake region, reasonable though often ineffective exposure control approaches are to reduce the velocity to deprive the wake of energy needed for eddy formation (i.e., maintain laminar flow) or to increase the flow rate to provide sufficient dilution. In either case, one problem is solved while another is created.

From this coupling arose the motivation to simul-

taneously achieve contaminant removal and eddy reduction in the wake region by introducing a directionally oscillating jet. A 50th percentile male mannequin was placed in a nearly uniform flow of approximately 35 fpm. While the cross-sectional velocity profile varied somewhat, smoke release studies indicated no back flow except near the supply wall. A low-velocity tracer gas source (isobutylene) was held in the standing mannequin's hands with the upper arms vertical and the elbows at 90 degrees.

Four ventilation scenarios were compared in terms of time-weighted average (TWA) concentration in the breathing zone as measured by photoionization detectors: 1) uniform flow; 2) addition of a steady jet (~1000 fpm) directed at the mannequin's back, parallel to the main flow; 3) making the jet oscillate to 45 degrees on either side of the centerline with a period of about 12 seconds; and 4) introducing a blockage at the centerline so the oscillating jet never blows directly at the worker.

At the 95% confidence level, the interrupted oscillating jet (Case D) achieved at least 90% exposure reduction compared with the uniform flow by itself or with the steady jet (Case A or B), and at least 35% exposure reduction compared with the unblocked oscillating jet (Case C).

## 232

THE EFFECT OF WIND SPEED UPON AEROSOL PENETRATION INTO AN ENCLOSURE. W. Heitbrink, NIOSH/Division of Physical Sciences and Engineering, Cincinnati, OH; E. Thimons, J. Organiscak, A. Cecala, NIOSH/Pittsburgh Research Laboratory, Pittsburgh, PA

Environmental enclosures are used on vehicles used in agriculture, construction, and surface mining to protect the operator from exposure to air contaminants such as pesticides and respirable crystalline silica. A recent ASAE standard (S525) specifies an enclosure static pressure of at least 6 mm of water. This specification was based on professional judgment rather than data. Application of Bernoulli's equation indicates that air infiltration through holes occurs when the enclosure static pressure is less than the wind's velocity pressure.

To test this hypothesis, the effect of wind speed on aerosol penetration into an idealized enclosure was studied. The idealized enclosure was a plywood box, 1.2 m × 1.2 m × 1 m in volume. Two fans supplied 1.7 m3/min of filtered air to this enclosure at a static pressure of 2.8 mm of water. The enclosure had three 1.6 cm diameter holes in the front and a 7.5 cm diameter vent port that was isolated from the airflow around the enclosure.

The airflow from an ultralight aircraft was directed at the front of the enclosure to simulate wind. The air speeds were varied between 14 km/hr and 36 km/hr, as measured by a rotating vane anemometer. An electronic manometer measured the static pressure in the enclosure. Two optical particle counters measured the particle number concentration of particles between 0.35 µm and 0.5 µm inside and outside the enclosure. Aerosol penetration into the enclosure was computed as the ratio of the aerosol concentration inside the enclosure to the concentration outside the enclosure. Aerosol penetration into the enclosure and cabin static pressure increased linearly with air velocity above 20 km/hr.

When simple linear regression was used to model the observed penetration as a function of the estimated penetration, the value of the slope was 0.69±0.12 ($p < 0.0001$).

The experimental data are consistent with the hypothesis that the enclosure static pressure must be higher than the wind's velocity pressure to minimize aerosol penetration into an environmental enclosure. Thus, the aerosol penetration into enclosures meeting the ASAE requirement of 6 mm of static pressure would be unaffected by wind speeds that remain below 35 km/hr.

## 233

FILTRATION EFFICIENCY OF ENVIRONMENTAL TRACTOR CAB FILTERS. E. Moyer, S. Martin, NIOSH, Morgantown, WV

In the United States, more than 5 million workers are involved in agricultural production. NIOSH has a long-standing initiative for investigation and prevention of occupational health and safety problems within the agricultural industry. A key component of this program is protecting the respiratory health of workers in the agricultural industry.

Agricultural workers can be exposed to pesticides, dusts and mists, bacteria, fungi, endotoxin. Exposure to these particulates can take place within environmental tractor cabs. Cab filters are not required to meet the same testing criteria as particulate respirator filters certified under 42 CFR 84.

New and used particulate filters from environmental tractor cabs have been evaluated for filter penetration as a function of particle size in the submicrometer size range of 0.03-0.4 µm. Further, the cab filter media were tested against a solid sodium chloride aerosol and/or a liquid DOP aerosol as explained in 42 CFR 84, except that flow rates were adjusted for velocity differences. The most penetrating particle size for these filters are in the range of 0.1-0.3 µm, as is the case for respirator particulate filters.

The data indicate that a broad range of filters and filter combinations with highly varying efficiencies (10%-99% at submicrometer particle sizes) are used in environmental tractor cab filtration units.

## 234

AN EVALUATION OF WET AND DRY METHODS FOR DECREASING EXPOSURE TO REFRACTORY CERAMIC FIBERS (RCF) DURING GRINDING AND SANDING. K. Dunn, A. Cecala, S. Shulman, J. Cleary, NIOSH/Division of Physical Science and Engineering, Cincinnati, OH; D. Venturin, Unifrax Corporation, Amherst, NY; S. Chen, Thermal Ceramics, Augusta, GA; J. Treadway, Premier Refractories International, Erwin, TN

A cooperative research study is being performed by researchers at NIOSH and the Refractory Ceramic Fibers Coalition (RCFC) to determine cost-effective methods for lowering worker exposure to RCFs. The results of sampling at manufacturing and downstream plants have shown that many of the highest documented exposures were encountered in the finishing (grinding, sanding, and sawing) of RCF products.

A preliminary study was conducted to evaluate the potential for wet and dry control methods to reduce worker exposure during grinding and sanding. A series of test runs were carried out at NIOSH's Pittsburgh Research Laboratory. The local exhaust ventilation (LEV) consisted of two hoods, while the wet control method consisted of a simple compressed air atomization nozzle directed at the RCF product during machining. A series of test runs were performed according to the following sequence: 1) LEV on; 2) water mister on; and 3) control off. Personal breathing zone and area samples were collected during each 10-minute trial run.

Grinding data and sanding data were analyzed as two separate experiments. For grinding, the personal breathing zone (BZ) concentrations showed a 99% reduction for LEV relative to no control and a 88% reduction with water mist relative to no control. Overall, both comparisons are statistically significant at the 5% level.

For belt sanding, the personal BZ concentrations showed a 99% reduction for LEV relative to no control and a 42% reduction with water mist relative to no control. At the 5% significance level, the LEV reduction is statistically significant, but the water mist is not.

The results of this study may be useful in developing controls that can be used by both the manufacturer and downstream RCF customers.

## 235

CONTROL MEASURES FOR REDUCING EMPLOYEE EXPOSURE TO CONCENTRATIONS OF TOTAL AND RESPIRABLE SILICA IN THE READY-MIXED CONCRETE INDUSTRY DURING TRUCK DRUM CLEANING. K. Sam, D. Williams, Illinois Department of Commerce, Chicago, IL

Periodically, drivers of ready-mixed concrete trucks enter the mixer drum to remove dry concrete buildup from the mixer. Using a pneumatic chipper and a sledge hammer, they chip out the concrete, which contains from 4% to 22% silica. During the chipping process, the drivers are exposed to concentrations of total dust containing silica and respirable silica that are as much as 10 times higher than the OSHA permissible exposure limits (PELs). This level of silica exposure is of significant concern to ready-mixed concrete facilities not only because of the health issues for their employees, but also because of OSHA's ongoing Special Emphasis Program for silica, which focuses enforcement efforts on companies where employees have the potential for silica exposure.

The purpose of this study was to identify effective and feasible control methods to reduce employee exposures to silica below the PELs during the chipping process. Personal air sampling was conducted at six ready-mixed concrete facilities using variations in ventilation configuration, portable exhaust ventilation, and wet methods during the chipping process.

Respirable dust sampling was conducted using a nylon cyclone with a flow rate of 1.7 L/min. Total dust with silica and respirable silica samples were collected and analyzed in accordance with the OSHA ID 142/NIOSH Method 7500.

Air sampling results confirmed employee exposure to silica can be reduced below the OSHA PEL during the chipping process by modifying the company's own pneumatic chipper using materials typically found in the maintenance areas of most ready-mixed concrete facilities. This would eliminate the need for respiratory protection for the employee and provide a safer work environment.

# Computer Applications Papers 236-244

## 236

DIRECT DATA ENTRY USING A PALM-TOP COMPUTER IN A LARGE EPIDEMIOLOGIC AND ENVIRONMENTAL STUDY. S. Reynolds, E. Svendsen, C. Taylor, K. Kelly, University of Iowa, Iowa City, IA

Small, versatile palm-top computers have proliferated in recent years, offering industrial hygienists a powerful tool for exposure assessment. These

# AIHCE 2000

The premier occupational and environmental health and safety conference & exposition

May 20–25, 2000

Orange County Convention Center

*Orlando, Florida*

Cosponsored by AIHA and ACGIH

## PREVENTION —

Our Mission
for the 21st Century

# *Abstracts*