Bitrex test solution when wearing a full-facepiece respirator equipped with a leaking exhalation valve retainer. The mean fit-factor for the 20 subjects who could not detect the Bitrex test agent was 86 (range 70-98).

The results reveal a large false-negative rate (77%) for fit-testing full-facepiece respirators with a commercial solution of Bitrex when known leaks are introduced through the exhalation valve retainer.

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ADEQUACY OF SIX EXERCISES FOR LABORATORY TESTING OF RESPIRATOR PERFORMANCE. Z. Zhuang, C. Coffey, P. Jensen, R. Lawrence, D. Campbell, NIOSH, Morgantown, WV

Since respirator workplace studies had consistently found no correlation between quantitative fit-factors and workplace protection factors, a previous study took a new approach that compared fit-factors with actual exposure doses of 1,1,2 trichloro-1,2,2 trifluoroethane (Freonâ-113) received while wearing half-masks. In that study, ambient aerosol (AA) and corn oil (CHD) fit-test methods were found to be predictive of actual half-mask respirator performance. However, how many exercises should be used in laboratory testing of respirator performance?

The purpose of this present study was to compare the fit-factors obtained from a more standard set of six exercises with the results from a set of 17 simulated workplace exercises. Each of 30 subjects wore up to 10 full-facepiece respirator models. The subjects were fit-tested with the PortaCount™ using six exercises to obtain fit-factors. Without redonning the respirator, the subjects entered a chamber and performed 17 simulated workplace exercises for 30 minutes, during which the performance of the respirator was measured with either the AA method or the CHD method. For the AA method, ambient aerosols were measured with the PortaCount. For the CHD method, corn oil was generated and measured with a photometer using a flow rate of 5 L/min and a deep probe.

The overall average of fit-factors for the 17 exercises was defined as simulated workplace protection factor (SWPF). The logtransformed fit-factors were significantly correlated with the logtransformed SWPFs from the AA method ($p < 0.0001$, $r2 = 0.95$) and the results from the CHD method ($p < 0.001$, $r2 = 0.90$). Paired-sample comparisons indicated that fit-factors were not significantly different from the SWPFs by either AA or CHD method ($p > 0.05$).

The results of this study suggest that the set of six exercises is adequate for laboratory testing of respirator performance.

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EVALUATION PROTOCOLS FOR SURFACE SAMPLING METHODS. R. Lawrence, OSHA Salt Lake Technical Center, Salt Lake City, UT

The Methods Development Team at OSHA's Salt Lake Technical Center has adopted evaluation guidelines to be used in the development of validated air sampling and analytical methods. The production of validated surface sampling methods must also be guided by a similar set of protocols. Toxic effects, workplace exposure, sampler capacity, extraction efficiency, storage effects, interferences, precision, and reproducibility are issues and considerations that comprise a sampling and analytical method evaluation protocol.

There are similarities and differences when comparing surface sampling method protocols and air sampling protocols. The surface sampling method protocols that were developed are now being used to produce validated surface sampling methods for aromatic amines, isocyanates, glycol ethers, and beryllium at the OSHA Salt Lake Technical Center.

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DERMAL EXPOSURE TO POLYCYCLIC AROMATIC HYDROCARBONS AMONG FINNISH COKE OVEN WORKERS. L. Pyy, M. Mäkelä, Finnish Institute of Occupational Health, Oulu, Finland

The exposure of workers to polycyclic aromatic hydrocarbons (PAHs) was studied in a Finnish coking plant between 1988 and 1994, since the beginning of production. Hygienic measurements, including dust and vapor sampling, were performed, and the correlations between the concentrations of airborne pyrene with the levels of 1-pyrenol in urine were calculated.

Measurements suggested that the progress of working conditions was favorable because the mean exposure level of shift workers to benzo(a)pyrene decreased from 2.5 µg/m3 to 0.3 µg/m3. The mean concentration of 1-pyrenol in urine had been 0.2-0.6 µmol/mol creatinine.

After the study phases, the follow-up of exposure has continued as a routine occupational hygiene services and biomonitoring. In May of 1998, it was found that the PAH concentration in the air had surprisingly increased to a level 1.6 times to 3 times higher than in 1994. Also, urinary 1-pyrenol concentrations had increased seven-fold when compared with the level in 1994.

Dermal exposure also was tentatively estimated among three workers. Skin contamination was measured with exposure pads on the wrists and by handwiping with sunflower oil. Pyrene contamination in wipe samples was 7-48 ng/cm2 and on pads 1-31 ng/cm2. The pyrene concentration in the breathing zone was 4-8 µg/m3, and the average 1-pyrenol concentration was 2 µmol/mol creatinine.

According to the model of Leung and Paustenbach, it may be estimated that dermal pyrene uptake is 66%-86% of the total absorbed amount of pyrene. On the basis of that situation, a new more comprehensive study has been started with a view to plan measures for control of skin exposure.

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EPICUTANEOUS EXPOSURE TO ISOCYANATE IN AUTOBODY SHOPS: A QUALITATIVE ASSESSMENT. Y. Liu, J. Sparer, M. Cullen, M. Stowe, C. Holm, C. Redlich, Yale University School of Medicine, New Haven, CT; S. Woskie, D. Bello, University of Massachusetts-Lowell, Lowell, MA

Little is known about the extent of surface contamination by hexamethylene diisocyanate (HDI) in autobody shops, its relation to epicutaneous exposure, and the effectiveness of personal protective equipment. The purpose of this study was to qualitatively evaluate such contamination and exposure in nine shops that participated in a large epidemiological study on isocyanate asthma.

Environmental surfaces were evaluated using a SWYPESTM wipe-sampling technique, a detector that changes to orange-red color when HDI is present. The color intensity was rated on a 0-5 score scale, with 5 as the heaviest contamination (deep-red) and 0 as no contamination (no color).

The skin of painters and repair technicians was similarly assessed using skin SWYPESTM. Permea-Tec pads were used to examine breakthroughs of HDI through gloves and protective clothes. A positive rate (with scores 1-5) for each shop was calculated as positive samples over total samples, and an average intensity score was calculated as cumulative score divided by total samples.

Results showed the positive rate for surfaces averaged 26% (0%-61.5% range) with the highest values for mixing, coating, and cleaning equipment and gloves. The intensity score for surfaces averaged 0.6 (range 0-1.8). Positive rate and intensity score for the skin were 25.9% (range 4.3%-60.9%) and 0.5 (range 0.1-1.2), respectively.

The tasks with the highest positive skin rate and score were clear coating (rate vs. score: 38.6% vs. 0.5), priming (28.6% vs. 0.8), sanding dry coats (24.3% vs. 0.5), and sealer coating (11.1% vs. 0.2). The positive rate and intensity score for gloves were 21.4% (range 0%-50%) and 0.4 (range 0-1). Breakthroughs of paint coveralls were also detected.

These results suggest surface contamination and epicutaneous exposure may make a significant contribution to the total exposure to HDI. They also point to the inadequacy of current personal protective equipment.

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EXPOSURE TO PESTICIDES DURING AIR SPACE SPRAYING INDOORS. M. Roff, Health and Safety Laboratory, Sheffield, United Kingdom

In the United Kingdom, there is a considerable market for pesticide products for use in the home. In approving such products for sale, risk assessments must be carried out that take the application task into account. Very little data on contamination rates for domestic users are available. Data on the dermal route are particularly scarce, and approvals are currently based on mathematical models and worst-case assumptions.

In this study, dermal and respiratory operator exposure was measured, arising from use of prepressurised aerosol spray cans, trigger sprayers, and pumpable sprayers. Volunteers wore T-shirts, shorts, and sandals to apply a surrogate formulation in an unventilated room 3 m2 in size. The subjects entered the room, sprayed the air around and above the head, then waited one minute before leaving the room. This was repeated four times.

The formulation contained fluorescent dye that was measured in situ on the skin under ultraviolet light using HSL's FIVES fluorescence monitor. It also contained strontium chloride salt, which was recovered efficiently from separate rinses of the head and limbs by washing in pure water. It was also recovered from IOM personal inhalable air filters, and from glass slides and filter papers that were left on surfaces during the tests and overnight. The strontium was assayed using inductively coupled plasma-mass spectroscopy (ICP/MS).

Dermal exposure was ~200 mg/min of formulation, and was similar for all applicators; 80%-90% was to the spraying hands. There was good agreement between strontium and dye results, except for the aerosol cans, since the dye crystalized inside the cans. Inhaled air concentrations were ~70 mg/m³ for trigger and pumpable sprays, but ~200 mg/m³ for the higher pressure cans. Surface residues were typically <1 mg/cm² on horizontal surfaces and <0.1 mg/cm² on vertical surfaces. Air concentrations and surface residues agreed with previous studies.

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