

than ice water quenching. Three extractions with hexane are optimal except for formaldehyde oxime, which requires precipitation and centrifugation. Quantitative analyses for purity and yield were done by gas chromatography/electron capture detection and gas chromatography/mass spectrometry, using nonpolar capillary gas chromatographic columns.

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### VOLATILE ORGANIC COMPOUND (VOC) OFF-GASSING FROM RESIN SYSTEMS DURING THE CURING PROCESS. G.

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The curing process of most resin systems is an exothermic reaction with a resultant off-gassing of VOCs. The composition and concentration of the off-gassing is highly dependent upon the chemical composition of the resin system and the volume and ventilation in the area where the mixing and use of the chemicals occurs. A potential exists for exposure to concentrations of hazardous chemicals at concentrations exceeding OSHA's permissible exposure limits (PELS) and/or ACGIH's threshold limit values (TLVs). This study was conducted to determine the composition of VOCs in the off-gassing of six different resin systems and quantify concentrations in a confined space.

Three of the resin systems were vinyl ester based, two were phenol-formaldehyde based resins, and one was a proprietary resin system. The resins were catalyzed with a specific compound such as benzoyl peroxide, methyl ethyl ketone peroxide, formaldehyde, paraformaldehyde. The chemicals were mixed in a sealed nonventilated chamber and allowed to cure. Air samples were taken on triple bed sorbent tubes and analyzed by gas chromatography/mass spectrometry using thermal desorption.

Styrene, formaldehyde, and furfural were measured at concentrations which exceeded the applicable PELs/TLVs in five of the six resin systems. The sixth resin system off-gassed benzyl alcohol at 4.5 mg/m<sup>3</sup>. These data indicate that a potential exists for worker exposure to several hazardous chemicals at concentrations exceeding the PEL and/or TLV. This potential is higher for work requiring extended use of the resins in confined spaces.

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### A SAMPLING AND ANALYTICAL METHOD FOR THE SIMULTANEOUS DETERMINATION OF MULTIPLE ORGANONITROGEN PESTICIDES IN AIR.

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Lack of accurate exposure estimates has been a weak link in associations of pesticide exposures with occupational illnesses. To provide more accurate airborne exposure information, an air sampling and analytical method was developed for organonitrogen pesticides using a combined filter and XAD-2 sorbent sampler and high performance liquid chromatography (HPLC)-ultraviolet detection (UV). The method was evaluated for 14 organonitrogen pesticides by NIOSH evaluation guidelines and procedures. Evaluation

experiments addressed limits of detection and quantitation, analytical recovery, sampler capacity, sample stability and precision and bias over a range of 12 to 240 g per sample. Samples were stable when stored for up to 30 days under either ambient or refrigerated conditions. Based on the finding of this work, 10 (aldicarb, captan, carbaryl, carbofuran, chlorpropham, diuron, forfometanate, methiocarb, oxamyl, propham) of the 14 compounds studied can be successfully determined simultaneously using one method with an accuracy of better than +25% of the true value with 95% confidence. Two other compounds (carbendazim/benomyl, methomyl) can be measured with the same accuracy over a more limited concentration range. The remaining two compounds (propoxur, thiobencarb) may meet this criterion, but additional samples would need to be included in the data analysis. With the current data, these two compounds can be determined with an accuracy of better than +27% of the true value with 95% confidence. This method will be included in the next edition of the NIOSH Manual of Analytical Methods as Method 5601.

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### IMPROVED METHOD FOR QUANTIFYING ASBESTOS BELOW 1% BY WEIGHT IN BULK SAMPLES BY TRANSMISSION ELECTRON MICROSCOPY. M. Floyd, J. Fisher, B. Beadnell, A. Cuthbertson, Forensic Analytical Specialties, Inc., Hayward, CA

Regulatory pressures, the acknowledged imprecision of the traditional polarized light microscopy (PLM) analysis at low levels, and PLMs 1% detection limit have prompted the application of transmission electron microscopy (TEM) in determining the asbestos content in bulk samples at or below the 1% by weight level. The semiquantitative TEM floor tile (i.e., "Chatfield") procedure is well suited for that matrix, but has serious drawbacks when applied to other bulk sample types. Gravimetric residue suspensions are not uniformly represented in aliquots, particle distribution on prepared TEM grids is uneven, and the assumption that semiquantitatively determined area percent and actual weight percent are equivalent is suspect. An improved method is presented in which gravimetry is first performed to remove organic and acid-soluble components from the sample. Aliquots of the resulting residue are then filtered and mounted on TEM grids following standard procedures. Properly loaded grids are scanned at 2500x for large asbestos structures, and at 20,000x for smaller structures and fibers. Different aliquot volumes may be used for each scan, depending on the particle loading in the size of interest in the scan. The dimensions of detected asbestos structures are recorded and, using the known densities of the asbestos varieties detected, the mass of each structure is determined. Back-calculating through the sample preparation procedures results in the weight of asbestos in a known starting weight of sample, or weight percent asbestos. Detection limits as low as 0.0001 weight percent may be attained. The accuracy of this procedure has tested favorably against NIST standards and proficiency samples.

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### COMPARISON OF THE PRECISION OF DUPLICATE FIELD SAMPLES FOR VOLATILE ORGANIC COMPOUNDS (VOCs) ANALYZED BY SUMMA CANISTER AND MULTISORBENT METHODS. G.E. Hadwen, J.F. McCarthy, Environmental Health & Engineering, Inc., Newton, MA; S. Womble, U.S. Environmental Protection Agency, Washington, DC

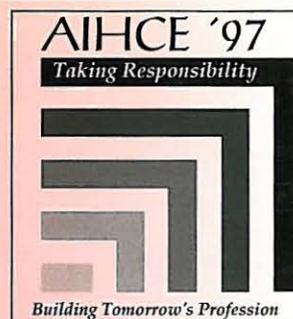
The purpose of the Environmental Protection Agency's (EPA's) Building Assessment and Survey Evaluation (BASE) study is to characterize many of the parameters associated with indoor environmental quality in non-problem office buildings. For the BASE study, the EPA attempts to collect measurements with the greatest degree of precision and accuracy possible. This analysis compares the precision of duplicate volatile organic compound (VOC) samples collected for the BASE study by two methods. For the BASE study, over 200 evacuated canister samples for VOCs, including 66 duplicate pairs, were collected in 34 buildings and analyzed by EPA Method TO-14. Twenty-eight multisorbent media samples, including 8 duplicate pairs, were collected in 4 of the 34 buildings and analyzed by a modified version of EPA Method TO-1. Each canister and multisorbent sample was analyzed for between 29 and 59 analytes. Precision was determined by calculating the duplicate residual for each analyte of each duplicate pair. The duplicate residual is the absolute value of the difference between the concentrations of the given analyte on each sample of the duplicate pair. This analysis indicated that the mean duplicate residual by multisorbent media, 0.29 parts per billion (ppb), was significantly lower ( $p < 0.00001$ ) than the mean duplicate residual by the canister method, 1.59 ppb. For many studies, the precision of either method may be adequate. Selection of appropriate sampling method depends upon the needs of the particular study, the analytes of concern, the precision required, and the convenience of the methods. Future needs include a comparison of the accuracy of the two methods.

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### AN EVALUATION OF AN ENERGY DISPERSIVE PORTABLE SPECTROMETER FOR DIRECT MONITORING OF INORGANIC CONTAMINANTS. H.M. West, F.N. Medes Sheffield Hallam University, Sheffield, UK

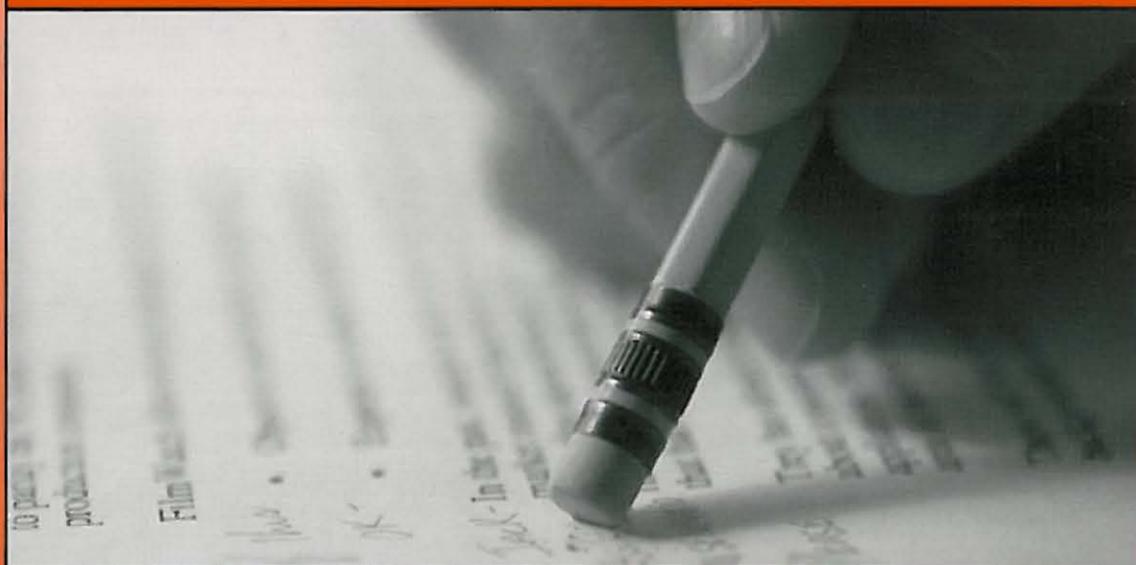
The advent of portable X-ray spectrometers with energy dispersive detectors that do not require liquid nitrogen cooling offers the opportunity for direct measurements of workplace contamination. This study assessed analyser software and determined lower limits of detection for a range of analytes of interest. A critical comparison was made between a pre-calibrated portable energy dispersive X-ray fluorescence spectrometer (Spectrace SP9000) and a conventional laboratory based wavelength dispersive system (Philips PW2400). The ability of the SP9000 thin film calibration to convert measured intensities into meaningful concentration data was tested by measuring known amount of oxides deposited on AA Millipore filters. Line overlaps and inter-ele-

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## Abstracts

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