In a recent bridge replacement project there were seven state and federal agencies each performing a different risk analysis. These agencies employed a variety of methodologies to protect workers, endangered species, the water supply, the ambient air quality and the public. In addition to regulatory constraints, there were contractual constraints among the different parties performing the work. Left unchecked the current system would have resulted in (1) the asbestos abatement preventing completion of the bridge before winter forcing local residents, school buses, and emergency vehicles to drive 30 miles on snow and ice covered roads, and (2) burying 1800 tons of steel in a landfill because it was coated with asbestos containing paint that was identified only after the contract to perform the work had been signed.

Asbestos levels are regulated to prevent a 1:1,000,000 chance of mesothelioma. The chance of dying in a fatal automobile accident is about 1:100. The principal risk in this scenario appears to be from increasing the chances of a fatal auto accident by increasing the driving distance on snow and ice covered roads. While there is no great risk in burying steel, it does squander resources and violates the principles of sustainable development and industrial ecology.

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EVALUATION OF THE ADEQUACY OF THE MIXTURE FORMULA (EM) IN PREVENTING OVEREXPOSURE TO SOME NEUROTOXIC GASOLINE COMPONENTS. J. Dennison, M. Andersen, R. Yang, Colorado State University, Fort Collins, CO.

Evaluating exposures to more than one chemical that exert similar toxic actions by using the "Mixture Formula" is recommended by ACGIH and required by OSHA. The Mixture Formula essentially assumes that exposures exhibit linear pharmacokinetic (PK) and pharmacodynamic dose response relationships and that the effects are additive in nature, i.e., no interactions occur between chemicals. To explore the hypothesis that the additivity assumption for PKs is valid, we used physiologically-based PK modeling to assess potential interactions for a series of chemicals with relatively simple dose metrics, the alkyl benzenes. The PBPK model was first used to calculate the target tissue dose for single chemicals, based on the premise that their TLVs were adequately protective. A PK-Em was then developed from the sum of ratios of the tissue dose of each chemical during co-exposures to the dose for single exposure for each chemical. The PK-Em was estimated for a variety of mixture exposures that would be allowable under the standard Em equation. The PK-Ems indicated that for two chemicals that act as clear CNS depressants, the Mixture Formula works reasonably well. However, when interacting solvents such as MTBE are excluded from the Em because they are not expected to cause CNS depression, the PK-Em suggests that an overexposure can occur. Moreover, if chemicals can make a secondary contribution to toxicity, even greater over-exposures can occur. This study provides preliminary evidence that the Mixture Formula approach may need further examination. This study was supported in part by a Cooperative Agreement from ATSDR (UGI/ATU 881475).

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WASTEWATER POLLUTANT DISPERSION, MODELING, CALCULATIONS AND MAPS, THREE WEST VIRGINIA FACILITY DISCHARGES TO OHIO RIVER, 1997. D. Whaley, G. Srinivasan, West Virginia University, Morgantown, WV.

The upper Ohio River, in Pennsylvania, Ohio and West Virginia, has many sites of permitted industrial wastewater discharges, and some municipal supply water intakes. Our purpose was to model and map process wastewater contaminant dispersion from three West Virginia manufacturing facilities whose discharges were hazardous and large, as determined by ranking using the Purdue chemical hazard weighting score and mass releases from Toxic Release Inventory reports for 1997. Maps were created using geographic information systems (GIS), and the modeling used Water Characterization and Modeling System (WCMS), a modification of GIS developed at West Virginia University Division of Resource Management. Modeling of one facility showed downstream ambient levels insignificant, compared to U.S. drinking water standards, but did show substantial loading for total suspended solids and phosphate, downstream only. However, the upper Ohio River functions as a series of constrained pools between locks and dams, with inconsistent flows determined by their operators, the U.S. Army Corps of Engineers. Also, the upper Ohio River driving gravitational flow gradient is so slight that the resolution of the digitalized terrain data from the U.S. Geological Survey, used by WCMS, sees the valley as flat. Therefore, modeling showed dispersion both upstream and downstream within constraint pools for the other two of these three facilities, suggesting community exposure to accumulated hazardous discharges. We conducted independent mass balance calculations of ambient contaminant concentrations for these two facilities, showing essentially the same result, low concentration exposures upstream and downstream — contributions from these facilities. We mapped West Virginia municipal supply water intakes, showing that only a few intakes were potentially impacted, upstream and downstream along the Ohio River. This work is foundation for studies of discharge dispersion and municipal intakes along the Pennsylvania and Ohio shores, to estimate the total cumulative ambient pollution, for comparison with limited monitoring data.

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DEVELOPMENT AND APPLICATION OF AN OCCUPATIONAL ACCIDENTS ANALYSIS METHOD. A. Miguel, Universidade do Minho, Guimarães, Portugal; G. Perestrelo, J. Machado, SMGP - Consultores, Lda., Porto, Portugal.

The authors develop a method for the quantification of accident risk in 3 industrial companies of different sectors of activity, based on frequency and severity rating. Risk categories correspond to different accident types, according to ILO classification. An inquiry involving the workers of the industrial companies was conducted aiming at comparing the risk assessment with the workers' subjective judgment, based on their risk perception. The obtained results show that there are no significative differences between the objective risk assessment and the workers' subjective judgment.

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USE OF A DIFFERENTIAL PRESSURE-BASED DETECTOR TUBE TO MEASURE RESPIRABLE COAL DUST. J. Volkwein, R. Vinson, S. Vanderslice, S. Page, NIOSH, Pittsburgh, PA.

The National Institute for Occupational Safety and Health has evaluated a new version of a dust sampler at the Pittsburgh Research Laboratory. This device uses an inexpensive plastic disposable detector tube to provide an immediate indication of cumulative dust exposure. A low flow rate pump draws a dust sample through a foam section and onto a treated glass fiber filter. The respirable fraction of dust is classified using the section of porous foam. The increasing pressure differential across the glass fiber filter created by dust mass accumulation is measured and correlated with respirable mass. Triplicate differential pressure measurements are compared to triplicate measurements of respirable dust mass collected using the U.S. Coal Mine Dust Personal Sampling Unit. In this unit, a Dorr-Oliver cyclone classifies the respirable fraction with subsequent filter mass measurement. Results show that the differential pressure of specific filtration media can be an effective surrogate for respirable mass. Data show that there is a dependence on coal type, an effect of relative humidity, and an effect of altitude change. These dependencies are broadly within ±50% of the average response for all factors. There also appear to be two distinct coal type responses, perhaps related to coal rank. For specific coals the regression coefficients are better than 0.9. For general use the detector tube can be used to estimate respirable dust levels using laboratory generated calibration curves. However, calibration to a specific coal type improves accuracy to ±25% of the gravimetrically determined mass.

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A LABORATORY COMPARISON OF THE DIFFERENTIAL PRESSURE-BASED DUST DOSIMETER WITH THE PERSONAL GRAVIMETRIC RESPIRABLE DUST SAMPLER ON COAL DUST. V. Marple, P. Luna, B. Olson, University of Minnesota, Minneapolis, MN; J. Volkwein, NIOSH, Pittsburgh, PA; R. Ramani, J. Mutmansky, H. He, Pennsylvania State University, University Park, PA.

The approved gravimetric respirable dust sampler (GRD), used to measure the amount of respirable dust to which a miner has been exposed, can only provide data on the miner's exposure days after the sample has been taken. It is more desirable to have an instrument that can provide real time personal respirable dust exposure level data so that the miner can take corrective action. This need has led to the development of a respirable dust dosimeter (RDD) by the National Institute for Occupational Safety and Health. The RDD pulls air through a tube where a foam plug removes the large non-respirable particles and the respirable fraction of the dust is collected on a filter. A pressure transducer continuously monitors the pressure drop across the filter and displays the data in real time. This paper describes the results of a laboratory comparison between the RDD and the GRD. Dust from three coal seams, Pocohonatas, Pittsburgh and Kittaning, were used in the comparison and twelve RDD pressure drop/GRD respirable

mass correlations were made for each coal type in the range of 0.8 to 3.24 mg. All laboratory comparisons were made in a dust chamber that held six RDDs and twelve GRDs. At intervals of mass loading, three GRDs were turned off and the value of the pressure drops of the RDDs recorded. In this manner the pressure drops of the six RDDs were compared to four mass values. Each of the mass values was the average of three GRDs. Results showed that there was a linear relationship between the RDD pressure drop values and the GRD mass values. To check the resolution of the standard transducers in the dosimeters, they were compared to high-resolution transducers. In addition, a MOUDI cascade impactor measured the dust size distribution in the chamber.

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EVALUATION OF BETA ATTENUATION METHOD. C. Chen, J. Huang, Y. Weng, I. Lu, National Taiwan University, Taipei, Taiwan Republic of China; C. Kuo, China Medical College, Taichung, Taiwan Republic of China.

The beta gauge attenuation method of mass determination depends upon the near exponential decrease in the number of beta particles transmitted through a thin sample as the unit area density is increased. The performance of beta attenuation monitor can be suffered from several potential measurement artifacts. The major goal of this work is to identify the principal factors resulting in inaccuracy, and hopefully to provide measures to remedy these artifacts. A primitive beta gauge was built and tested in a calm air chamber. A constant output aerosol generator and an ultrasonic atomizing nozzle were used to produce challenge aerosols of different size distributions. An Aerodynamic Particle Sizer and a Scanning Mobility Particle Sizer combined system were used to measure the aerosol number concentration and size distribution. Beta ray passed through aerosol deposition on filter was recorded by a radiation meter. The principal operational parameters include challenge aerosol size distribution, environment relative humility, filter location, amount of aerosol deposit, and uniformity of aerosol deposition. The results showed that the beta intensity through the filter sample decreased exponentially with increasing aerosol deposit, as expected. Among the challenge aerosols, lead nitrate has the highest attenuation (0.968 square centimeter per mg), followed by NaCl and then PST. Aerosols of smaller size appeared to attenuate more beta ray than the larger particles, a phenomenon that needs to be studied further. The comparison study between beta gauge and TEOM showed that beta gauge normally reads higher aerosol concentration than does TEOM, probably due to the fact that TEOM measures the mass under a heated environment. The effect of uniformity of aerosol deposit on the beta attenuation methods could be significant. The beta penetration increased with decreasing coverage of aerosol deposit, given that mass of aerosol deposit was constant.

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A COMPARISON OF THE ASPIRATION EFFICIENCIES OF IOM PERSONAL INHALABLE AEROSOL SAMPLERS, OPERATING AT DIFFERENT FLOW RATES. S. Paik, J. Vincent, University of Michigan, Ann Arbor, MI.

The Tsai et al. semi-empirical model (1996) surprisingly predicts that a 20-fold scaling-down of flowrate on an IOM sampler does not change sampler aspiration efficiency significantly. If the model's prediction were true, the IOM sampler itself, without any modifications, would be sufficient as part of a lightweight sampling system (since it would require a much smaller sampling pump), to great benefit for many practical aerosol sampling situations. An experiment was therefore conducted to determine whether or not an IOM sampler running at a flowrate of 0.1 L/min measures the same aerosol mass concentration as another running at the recommended flowrate of 2 L/min. The variables in the experiment were sampling flowrate, dust grade, and external wind speed. Mass concentrations were measured for the two IOM samplers, each attached on one side of a miniature bluff body in a wind tunnel. Results from the experiment indicated that the IOM sampler, running at 0.1 L/min, collected higher mass concentrations than the IOM sampler, running at 2 L/min. The differences were reduced for finer particles and lower windspeeds. It is therefore immediately obvious that the scaling laws, based on the Tsai et al. model, have not correctly predicted the outcome. A possible explanation is that the model cannot accurately predict sampler performance for very high ratios of external windspeed and sampling velocity (R). While the model has previously been shown to hold for R-values up to 14, values as high as 212 were employed in this experiment. This is far outside the range of any aerosol sampling experiment previously carried out, for any sampling system. The results of the present experiment lead us to re-think the range of application of current knowledge of aerosol sampling theory.

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USE OF DERIVED CORRECTION FACTORS TO ESTIMATE METAL REMOVAL FLUID AEROSOL LEVELS USING A DIRECT READING REAL-TIME INSTRUMENT. M. Martinko, General Motors Corp., Ypsilanti, MI.

Automotive manufacturing facilities utilize a variety of metal removal fluids. Direct reading instruments can be of tremendous help in identifying areas where exposure to these fluids is above recommended guidelines. However, direct reading instruments often cannot differentiate between one type of fluid and another. The purpose of this study was to develop correction factors that could be used to accurately predict the level of metal removal fluid aerosols in the workplace based on measurements from direct reading real-time instrumentation. In order to develop the correction factors, we measured exposures to a variety of metal removal fluids using a type of direct reading instrument and the current NIOSH 0500 cassette method. The types of metal removal fluids included straight mineral oil, semi-synthetic fluid, oil rejecting semi-synthetic fluid and soluble oils. These fluids represent the types of fluids which were not only used in the highest volume but, based on operations, resulted in the highest number of employees exposed. Two sets of tests were run for each fluid involved in the study. Two different instruments from the same manufacturer were used for the tests. Comparison of the direct reading instrument and the cassette results indicated a correction factor of 0.8 for straight mineral oil, 0.93 for oil rejecting semi-synthetics, 1.34 for semi-synthetics and 1.08 for soluble oils. We concluded that oil rejecting semi-synthetics and soluble oils were read similarly by the direct reading instrument. The readings for semi-synthetics and straight mineral oils were somewhat more divergent. Semi-synthetics were overestimated (+34%) while straight mineral oils were underestimated (-20%). The overall average correction factor was determined to be 1.03. Considering that the machining environment often utilizes multiple fluids in a given area, our results indicate that the direct reading instrument can give a conservative yet relatively accurate determination of metal removal fluid aerosols in the workplace.

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USE OF REAL-TIME DIRECT READING AEROSOL MONITOR TO EXAMINE METAL REMOVAL FLUID ENGINEERING CONTROLS. M. Martinko, General Motors Corp., Ypsilanti, MI.

Metal removal fluid health concerns are increasing in many industrial facilities. At a major automotive facility several enclosures were engineered and constructed around machining operations to reduce the levels of metal removal fluid mist. The survey was conducted to determine if it was possible to use direct reading real time aerosol monitor data to evaluate the effectiveness of the engineered controls using statistical analysis and topographical concentration surface plot generation. Direct reading instrumentation was used to obtain levels of metal removal fluid mist during three phases of operating parameters. Sample points were determined by dividing the machining area into 40-foot by 40-foot grid squares. Three phases of operating parameters were then determined. No statistically significant difference was observed between the average samples taken during Phase I ($p < 0.43$) operations before and after enclosures were operational. A statistically significant reduction was observed between Phase II ($p < 0.017$) and Phase III ($p < 0.024$) operations before and after the enclosures were operational. Analysis using a t-test between samples from outside and inside the enclosure also indicated a statistically significant reduction ($p < 0.041$). Computer generated topographical concentration surface plots using these samples indicated the enclosures were effective in reducing metal removal fluid mist. Direct reading real time aerosol monitors can be used to determine the effectiveness of engineered enclosures. Certain desktop computer applications can also be used to more easily explain sample results and present these results to interested parties. The use of direct reading samples provides faster turnaround time than filter cassette analysis. Concentration surface plotting allows for better visualization of problem areas and targeting of specific areas for further control.

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A COMPARISON OF THE ANDERSEN SINGLE-STAGE (N-6) SAMPLER WITH THE ROTOROD SPORE TRAP IN TEST ATMOSPHERE CONTAINING VIABLE AND NON-VIABLE FUNGAL SPORES. B. Samimi, L. Brenner, J. Quintana, San Diego State University, San Diego, CA.

The Andersen Single-Stage (N-6) viable sampler is currently used for assessment of air contamination to fungal spores. The Rotorod, also an impactor sampler, is used primarily for collecting outdoors total spores and pollens. The objective of this study was to compare the collection efficiency of these samplers within an environmental chamber containing either viable spores or mixture of viable and non-viable spores of Cladosporium. The collection efficiency of the Rotorod sampler was also challenged by coating its collection rods with MDA media prior to sampling followed by post-sampling incubation and enumeration of the grown colonies directly over the rods. The samplers were run side-

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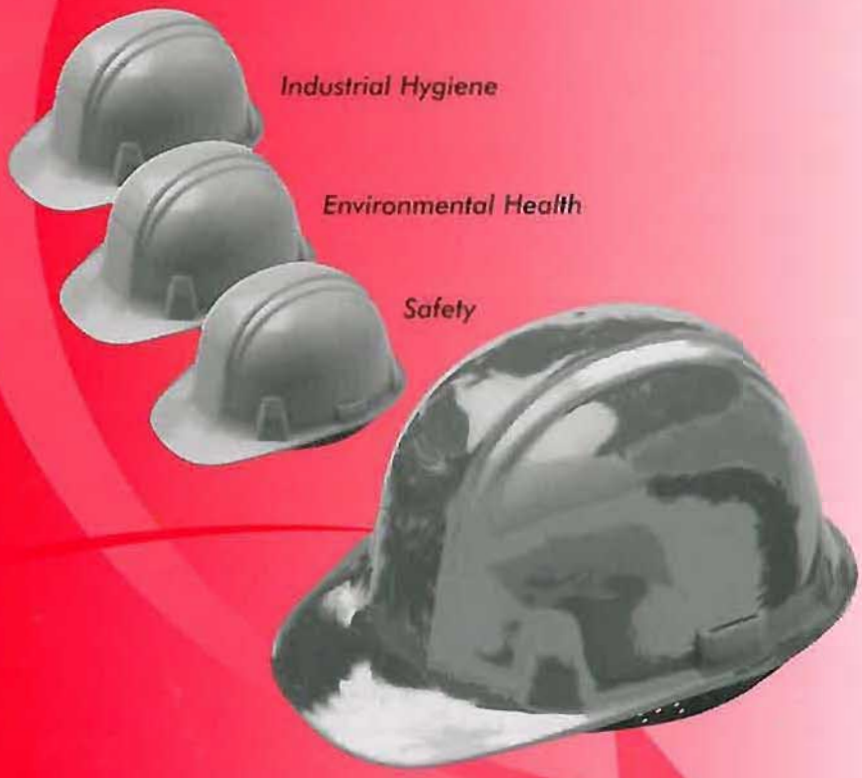

ABSTRACTS