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APPLICATION OF THE CENTRAL LIMIT THEOREM TO MONTE CARLO RETROSPECTIVE EXPOSURE ASSESSMENT OF WORKERS EXPOSED TO ASBESTOS-CONTAINING JOINT COMPOUND

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Random number generation of log-normally distributed variables can be utilized to simulate the variability and distribution of collected exposure samples as well as the variability and distribution of mean exposure data. Exposure data is virtually always log-normally distributed, often with a GSD between 2 and 4. The confidence interval for the TWA on any given day can have a relatively large range if day-to-day and location to location variability is justifiably included in the determination. However, the variation of the distribution of longer-term exposure data is often more relevant than day-to-day variation of the mean when considering the toxic effects of exposure. Industrial hygienists sometimes fail to recognize that the distribution of mean exposure values becomes significantly less log-normally distributed with larger n values more resembling a normal distribution. While the Central Limit Theorem states that normality of the distribution of a mean will be achieved with an infinite number of collected samples, for each mean estimation, inclusion of a more modest number of samples also significantly increases normality. Determination of the mean TWA distribution from log-normally distributed exposure data collected over a modest number of days has the practical effect of tightening the associated confidence interval by the square root of n (utilizing the formula for standard error) as n increases. Also, the shape of the probability distribution changes with n, influencing the size of the confidence interval. These concepts will be demonstrated and verified with computer-programmed simulations utilizing log-normal random number generation and applied via Monte Carlo simulation. As an example, the retrospective determination of mean TWA exposures for drywall tapers and sanders will be determined using these tools and presented in comparison with day-to-day TWA estimates.

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COMPARISON OF MODELED AND MEASURED CONCENTRATIONS OF AIRBORNE BENZENE FROM THE USE OF PETROLEUM-BASED SOLVENTS SPIKED WITH LOW LEVELS OF BENZENE

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In the absence of quality monitoring data, to estimate airborne concentrations of evaporating volatile organic compounds (VOCs), exposure assessors rely upon their professional judgment to appropriately select and use one of many consumer and industrial hygiene exposure models. This research was conducted to assess the accuracy of several models to predict indoor air concentrations resulting from the manual application of products containing low amounts of benzene. A simulation study was designed and conducted to assess the effects of six factors on air concentrations of benzene. These factors include: (1) the concentration of benzene in the solvent, from 0.001%-1% by volume, (2) the applied solvent volume, from 50 ml–150 ml, (3) the applied surface area, from 1 ft^2 to 9 ft^2, (4) the application technique, using either a rag or a spatula, (5) the solvent formulation, using either paint thinner or a consumer product containing mainly naphthenic and aliphatic petroleum distillate, and (6) the air exchange rate, from 4–10 ACH. In each sampling event, two personal and six area samples were collected over durations of 15–25 minutes. Personal and area concentrations of benzene ranged from 0.009–0.6 ppm and 0.004–0.2 ppm, respectively. Air concentrations were estimated in a Monte Carlo simulation using two-zone and turbulent diffusion models with steady, exponentially decaying, and instantaneous generation rates of benzene vapor. Model estimates compared favorably with measured air concentrations at low concentrations, although they did not adequately capture the marked nonlinear correlation between benzene concentrations in the bulk and those measured in air. This research provides an additional platform for professional judgment and a basis for justifying reasonable extrapolations from the 12 scenarios examined in this simulation.

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PROFESSIONAL JUDGMENT AND BIAS PART 1—LEARNING FROM THE SCIENCES

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Professional judgment is commonly used throughout the field of industrial hygiene to determine the acceptability of exposures and manage exposure control programs. Studies on professional judgment and its associated biases cover a wide range of fields including psychology, economics, medicine, and engineering. These studies indicate that humans use simple cognitive rules rather than extensive algorithms when making judgments. These simple decision rules are very efficient; however, they can be biased because of their simple nature. These simple cognitive rules common to human judgments have been called "heuristics" and have inherent biases associated with them that show up in studies across many fields. Several of the most common heuristics studied in a variety of science fields will be illustrated along with methods and strategies identified to address potential biases. The presentation will also discuss associations with several areas of industrial hygiene professional judgment and identify possible methods for controlling various forms of bias.

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VALIDATION OF TWO DIFFERENT EXPOSURE MODELS USING THE RESULTS OF A SIMULATION STUDY INVOLVING EXPOSURE TO METHANOL VAPORS DURING THE CLEANING OF SEMICONDUCTOR WAFERS

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A steady-state, single-compartment model (Model I) and a transient two-zone model (Model II) were evaluated using data from an exposure simulation study. The simulation characterized occupational exposure to methanol for workers who cleaned wafers in the quality control department of semiconductor manufacturing facilities. Two different exposure scenarios were evaluated. In the first scenario, a single worker used methanol at a rate of approximately 45 ml/hr while hand-washing wafers in a 102 m^3 room with a room ventilation rate of 10 ACH. In the second, more aggressive, exposure scenario, two workers performed the same task simultaneously in the room with a lower ventilation rate of 5 ACH, together using methanol at a rate of 95 ml/hr. Both personal and area samples were collected during the simulation. In the first scenario, Models I and II estimated breathing zone concentrations in the near field of about 60 ppm and 70 ppm, respectively, compared to the results of 12 personal samples, which averaged 60±46 ppm (mean ± SD). Both models predicted room concentrations of about 30 ppm, compared to the results of 36 room samples, which averaged 18±12 ppm. In the second scenario, Models I and II estimated breathing zone concentrations of about 160 ppm and 140 ppm, respectively, compared to the results of 16 personal samples averaging 118±50 ppm. Models I and II predicted room concentrations of about 110 ppm and 100 ppm, respectively, compared to the results of 16 area samples averaging 48±13 ppm. Our results indicate that the models tend to accurately predict airborne concentrations in the near field but that they tend to overestimate the room concentrations. Although slightly more complicated, the transient two-zone model appeared to provide a more accurate estimate of air concentrations near and away from the source than the single-compartment model.

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EVALUATION OF CONTROL BANDING THROUGH STATISTICAL ANALYSIS OF EXPOSURE MONITORING DATA

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This presentation describes a method of applying statistical techniques, including Bayesian statistics, to evaluate various control banding systems. Control banding is used by many industries and agencies for the purpose of defining exposure control strategies, often in the absence