

first annuals of the first set, school staff showed improvement on 40% of the indicators but met only 27% of goals. Implementation of the program showed that by the end of FY01, 71% of scheduled schools received the program. Customer satisfaction throughout the process showed 91% of goals being met. Program effectiveness indicated that although customer satisfaction remained high, IAQ parameters returned to pre-program levels in many cases.

Changes to improve the program such as delivery of training, scope of work, record keeping, and increased inter-departmental coordination have resulted from this evaluation.

Based on our total IAQ program, MCPS was awarded EPA's *Tools for Schools* 2001 Excellence Award in August 2001.

## 209. LABORATORY VARIABILITY ASSOCIATED WITH ANALYSIS OF ALLERGEN QA/QC SAMPLES. P. Ashley, U.S. HUD, Washington, DC; A. Pate, J. Menkedick, D. Morrison, Battelle, Columbus, OH; J. Halsey, IBT Reference Laboratory, Lenexa, KS

In October 1998, the U.S. Department of Housing and Urban Development (HUD) launched its Healthy Homes Initiative (HHI) to address multiple housing related health hazards. In implementing the HHI, HUD is currently funding various HHI research and demonstration activities.

Among the childhood diseases that HUD hopes to address through the HHI is asthma. It is widely known that many asthma sufferers are affected by common allergens in household dust. Numerous HHI projects are collecting and analyzing household dust samples for these key allergens; however, currently there are no readily-available QC dust samples that can be introduced into the sample stream. Also, there is limited knowledge about how much inter- and intra-laboratory variability may be associated with these analyses. Laboratories utilizing the same analytical technique may differ in their dust processing and extraction methods, accounting for some expected variability. HUD and Battelle conducted a study to assess laboratory variability associated with monoclonal enzyme-linked immunosorbent assays (ELISA) of dust containing common household allergens, and to identify an "acceptable range" of values for some target allergens.

A homogenized batch of dust containing a known amount of four specific allergens (Der f1, Der p1, Bla g1, Fel d1) was prepared using dust that had been collected from residential households. Seven laboratories were asked to analyze three replicates from this batch. A balanced analysis of variance statistical model was used to evaluate the amount of inter- and intra-laboratory variability.

Preliminary findings indicate that variability between laboratories was the majority of error for each of the allergens tested, ranging from 52% to 98% of the total variance. Inter-labora-

tory coefficients of variation were approximately 50% for three of the allergens, while intra-laboratory coefficients of variation ranged between 10% to 60%, with an average of 30%. Much higher variability was seen in the results for the fourth allergen.

## PF 128. Exposure Assessment Strategies II Papers 210-217

### 210. EQUATIONS FOR CALCULATING EXPOSURE MANAGEMENT OBJECTIVES FOR SINGLE SHIFT, LONG-TERM AVERAGE, AND DUAL EXPOSURE LIMITS. P. Hewett, NIOSH, Morgantown, WV

The majority of exposure limits for gases, vapors, and particulates have as their implicit or explicit goal the control of exposures for each employee. A measure of noncompliance for a typical single shift, TWA exposure limit (or for a 'long-term average' exposure limit) is the probability that a randomly selected worker has a 95th percentile exposure (or mean exposure) greater than the single shift limit (or long-term average limit). The goal of an exposure management program should be to ensure that this probability is small, say 0.05 or less. One method for determining if this goal has been achieved is to directly estimate the probability of noncompliance through the application of resource intensive, repeat sampling of randomly selected workers, followed by components-of-variance analysis.

Equations will be presented for calculating site specific exposure management objectives, that if met will help ensure that the exposure management goal is achieved. These equations were derived from a statistical model (which will be briefly discussed) designed to be applied to both conventional, single-shift TWA exposure limits and the less common 'long-term average' exposure limits. The objectives include a target group exceedance fraction, an alternative single shift limit, a target group geometric mean, and a target group mean. Each of these objectives can be evaluated using off-the-shelf sampling strategies, tolerable sample sizes, and robust data analysis procedures. If the site-specific control objective is met, the overall goal of exposure control for at least 95% of the employees is likewise achieved. Examples will be presented for single shift exposures limits, 'long-term average' exposure limits, and for dual limits, where both a single shift and 'long-term average' limit apply.

### 211. PERFORMANCE OF A COMPREHENSIVE MONITORING ALGORITHM IN A LARGE COMPANY'S INTEGRATED EXPOSURE ASSESSMENT PROGRAM. P. Logan, 3M, Decatur, AL; J. Mulhausen, 3M, St. Paul, MN

Computer database programs are helping to create fully integrated task based qualitative, semi-quantitative and quantitative exposure assessment systems to provide information for medical, epidemiological and exposure control programs. When properly designed, these systems can provide a systematic approach to address all chemical, physical and biological hazards. The performance of the decision logic used to manage quantitative monitoring and control programs is critical to the program's success. The presentation will review methods used to determine the performance of the decision logic used by a large company to manage qualitative and quantitative exposure assessment data. For the baseline assessment strategy a SEG with a true exposure profile characterized by a GSD = 2 and an OEL exceedance fraction of 10%, the probability of incorrectly declaring the SEG acceptable is 2%. Assumptions used for describing error in qualitative assessments will be described.

### 212. MEASURING THE SAME ATMOSPHERE WITH SHORT-TERM AND LONG-TERM FIBER SAMPLES: IT'S IMPLICATION FOR ASSESSING TWA EXPOSURES. F. Boelter, D. Cauley, F. Norlock, Boelter & Yates, Inc., Park Ridge, IL

A series of STEL samples does not add together to yield the same result as determined by a single long term TWA sample. If discrete, consecutive STELs are time-weighted averaged together, the result is at least an order of magnitude higher than would have been quantified from a single long term TWA sample. The phenomenon was quantified where a consistent, low-level background level of cellulose fibers ranged from 0.02 to 0.04 f/cc as determined by long term TWA sampling. Parallel STEL samples collected, without changing the conditions, quantified levels of 0.3 to 0.5 f/cc. All data was collected and analyzed in accordance with NIOSH Method 7400 for total fibers. The implications are significant for both sampling strategy design and data interpretation involving STEL samples when using the formula  $(TWA = (C_1 \times T_1 + \dots + C_n \times T_n) / (T_1 + \dots + T_n))$ . TWAs are used to address chronic effects while STELs and CL are reserved for contaminants exhibiting an acute effect. For some contaminants, a combination of a TWA and STEL or CL may be used to address both chronic effects as well as acute effects. For other contaminants, such as asbestos, the use of the STEL is intended for activities of short and intermittent duration and infrequent occurrence otherwise the full shift sample TWA would be more representative of a long-term average exposure. The authors caution against designing a sampling strategy using a series of short-term samples which will be used to mathematically calculate a TWA as significant bias will result.

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## ABSTRACTS



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## PF 101 Agricultural Health and Safety

Papers 1-6

### 1. RELATIONSHIPS BETWEEN WORK EXPOSURE AND RESPIRATORY OUTCOMES IN POULTRY WORKERS.

S. Kirychuk, J. Dosman, P. Willson, L. Dwernychuk, University of Saskatchewan, Saskatoon, SK, Canada; J. Feddes, A. Senthilselvan, C. Ouellette, University of Alberta, Edmonton, AB, Canada

A pilot study was conducted on 74 poultry barn workers in Western Canada during the winters of 1998-2000. General respiratory health, current, chronic and work related respiratory symptoms; general work duties, and work-site factors were ascertained, pre-exposure, by questionnaire. Personal airborne exposure levels and changes in symptoms and lung function were measured across the work-shift for all workers. Workers were classified according to the type of poultry operation (floor based, n=53; cage based, n=13) in which they worked. There was no significant difference in daily hours spent in the barn between those who worked with caged poultry (5.41±2.35 hours) and those who worked with floor-based poultry (4.42±2.48 hours). Age of birds was 47.10±58.36 days for floor based versus 155.91±63.01 days for cage based facilities.

There were no significant differences in personal environmental measurements between cage-based and floor-based facilities (ammonia 13.22±13.70 ppm, 17.34±16.35 ppm; total dust 5.74±4.85mg/m<sup>3</sup>, 10.01 ±8.84 mg/m<sup>3</sup>; endotoxin 6046±6089 EU/m<sup>3</sup>, 5457±5934 EU/m<sup>3</sup> respectively). There were no significant differences in across work-shift change in pulmonary function indices between workers from cage and floor-based operations. For the entire sample total dust dose (work hours/day x total dust) significantly correlated with across-shift change in FEV<sub>1</sub>, whereas endotoxin dose and ammonia dose did not. Stocking density was significantly correlated with average ammonia (ppm, p=0.002) and ammonia dose (ppm x work hours/day; p=0.004) in floor based operations and with total dust (particles/ml, p=0.002) in cage based populations. Stocking density was also significantly correlated with chronic cough (p=0.003) and across work-shift cough (p=0.05) and chest tightness (p=0.06) for workers from floor based operations; and with phlegm when working (p=0.018) and chest tightness across the work-shift (p=0.004) for workers from cage based operations. Type of poultry production operation and therefore type of work exposures appear to significantly impact symptoms experienced by workers exposed to these atmospheres.

### 2. DUST GENERATION SYSTEM FOR AGRICULTURAL SOIL DUST. K. Lee, R. Domingo-Neumann, R. Southard, UC Davis, Davis, CA

Agricultural workers are prone to exposure to mixed dust of inorganic and organic compounds. Diverse working conditions and operations in agriculture make direct measurements of the mixed dust exposure difficult. This study was conducted to develop a new dust generation system to determine possible exposure potency indicators of soil samples. The dust generator consists of a blower, a rotating chamber and a settling chamber. The rotating chamber has inner baffles to provide sufficient agitation of the samples while the chamber is rotating. A blower provides air into the rotating chamber, and the suspended dust is moved to the settling chamber through a perforated pipe. A small fan inside the settling chamber helps maintain suspension of the dust. Various size fractions of dust are sampled on filters suspended in the chamber via outlet ports and attached pumps. Air pressure is released through a filter plate mounted on the wall of the settling chamber. Various operating conditions were evaluated: air intake from blower, speed of rotation, soil mass and sampling time. To evaluate the characteristics of dust from the system, we collected dust samples from agricultural fields while the soil was prepared for