

tures and spot asbestos abatement as necessary. A project-specific industrial hygiene air sampling strategy was designed to evaluate the effectiveness of poly-barriers with an established negative pressure differential. The agents of interest with the potential for occupational exposures were airborne fibers, bioaerosols, and particle counts.

For each defined hospital area, a negative-pressure poly-containment was constructed. Spot abatement of sprayed-on fireproofing was performed using modified glovebag techniques, and airborne fiber area monitoring was completed. Particle counts were recorded both inside and outside each selected containment work area during numerous work days to attempt to establish a direct-reading monitoring parameter for this project. Bioaerosol monitoring was performed during two phases for containment work areas as baseline assessments and during conduct of work in the open ceiling plenum within the negative-pressure area.

Results from airborne fiber and also particle counts were variable and dependent on the level of disturbance both inside and out the containment areas. Bioaerosol monitoring results both as colony counts and relative ranking of the identified microbial agents indicate a variable pattern of distribution of airborne microbial agents. The data indicate the need for development and implementation of stricter infection control procedures for construction-related work within a hospital environment.

Based on the monitoring results obtained, modification of previously accepted work practices and procedures were designed to assure appropriate protection of patient, project, and hospital personnel as well as visitors within a health care environment.

134

ONE HOSPITAL'S PRESCRIPTION FOR ENVIRONMENTAL HEALTH AND MERCURY REDUCTION. D. Powell, Hartford Hospital, Hartford, CT

Hartford Hospital experienced 20 uncontrolled releases of mercury from January 1998 to December 1998. Having to rely on a licensed firm to handle hazardous materials, cleanup of these spills averaged \$3000. Variable costs were associated with these episodes depending on whether staff, patient, or visitor was affected by the free mercury.

Compliance with State Department of Environmental Protection Regulations required that the DEP spill division be notified with each occurrence. According to State records, during that same period, 287 spills were reported within the city limits of Hartford — 25 were mercury.

Hartford Hospital has made a commitment to maintain a healthy environment. In October of 1998, Hartford Hospital initiated an effort to reduce or remove mercury from the facility. An inventory of materials containing mercury was developed. Alternative nonmercury technologies were sought. Controlled laboratory evaluations and subjective user evaluations were performed on each alternative product.

A total of 765 wall-mounted and 200 portable mercury-containing sphygmomanometers were replaced with aneroid sphygmomanometers. Manufacture specifications indicate that each sphygmomanometer contained approximately one-quarter pound of elemental mercury, thus 241.25 pounds of mercury were eliminated from the facility at a cost of \$83,597. An additional 35 pounds was removed from the appliance servicing area where historically, the sphygmomanometers were serviced.

Mercury cantor tubes were replaced with a saline

substitute. Firestation pull switches will be replaced with nonmercury technologies as system upgrades occur. Fluorescent light bulbs have been recycled at our facility since 1997 (15,000 pounds recycled in 1997–1998).

Light bulb recycling has been a tremendous burden on our organization, as in Connecticut — these are not yet recognized as a universal waste and are tracked on hazardous waste manifests, thus counting on the organization's generator status.

135

INTEGRATING OCCUPATIONAL HEALTH AND SAFETY INTO POLLUTION PREVENTION INITIATIVES FOR HOSPITALS. H. Herman-Haase, M. Quinn, J. Tessler, L. Punnett, N. Haiama, M. Sabolefski, University of Massachusetts—Lowell, Lowell, MA

The hospital industry has been under increasing pressure to reduce wastes. In response, hospitals are beginning to practice pollution prevention (P²) by substituting polluting materials, medical products, and work practices with ones more environmentally sound. Changes in materials and practices to meet P² goals risk shifting hazards to the work environment if P² and occupational safety and health (OSH) are not evaluated in an integrated assessment. However, environmental and occupational assessments have traditionally been conducted separately.

The objectives of this study were 1) to develop a model to integrate OSH and P² assessment methods; and 2) to evaluate an integrated assessment in hospitals based on this model. The model was developed by combining elements of existing P² and OSH assessment methods, including P² production process mapping, process hazard analysis, and job hazard analysis. Integrated workplace assessment methods and questionnaires then were developed.

The applicability and effectiveness of the integrated assessment was evaluated by piloting it in clinical laboratories in three hospitals. P² process maps, including materials input and waste output for each process step, were created for histology and cytology processes. The jobs and tasks comprising each of the processes then were evaluated for OSH risks in five categories: safety, chemical, physical, and musculoskeletal hazards, and work organization. This was accomplished using observation, surveys, and questionnaires.

This information was integrated into the P² process maps, and the effects of changes in materials-use practices on selected P² and OSH outcomes were compared. It was found that P² initiatives to reduce mercury use in laboratories could negatively impact the work environment if worker exposures and job demands are not considered simultaneously with materials substitutions.

It is concluded that these methods can be used to evaluate the health and safety impact of materials changes in hospitals

Indoor Air Quality Papers 136–145

136

PROACTIVE INDOOR AIR QUALITY SURVEYS CONDUCTED IN METROPOLITAN NEW YORK COMMERCIAL BUILDINGS BETWEEN 1992–1998. J. Springston, W. Esposito, K. Cleversey, Ambient Labs, Inc., New York, NY

Between June 1992 and December 1998, 757 surveys were performed in 125 commercial office

buildings in metropolitan New York City as part of an ongoing proactive indoor environmental quality (IEQ) program. Sampling was performed in “non-problem” buildings during normal business hours on a quarterly, semiannual, or annual basis. The protocol used for the surveys was based on the EPA's *A Standardized EPA Protocol for Characterizing Indoor Air Quality in Large Office Buildings*. Among the various physical and gaseous parameters sampled for were carbon dioxide (CO₂), carbon monoxide (CO), total volatile organic compounds (TVOCs), particulates, temperature, and relative humidity.

This presentation focuses on the CO, CO₂, and TVOC readings. Measurements were taken using a Brüel & Kjær Multi-gas Monitor Type 1302[®], which uses a direct-reading infrared spectroscopy technique with a photoacoustic sensor.

For TVOCs, two groups were sampled: Group I, with a center wavelength of 3.4 μm, and Group II, with a center wavelength of 3.6 μm. More than 17,500 readings were analyzed, and the results were compiled to determine the mean and median readings, as well as the standard deviation, for each of those parameters. The subsequent graphs were then compared with various standards and/or guidelines applicable to the indoor environment.

CO₂ levels ranged from 357 ppm to 1960 ppm, with just more than 2.48% of the results exceeding the ASHRAE standard of 1000 ppm. Indoor CO levels ranged from 0 ppm to 60.3 ppm, with approximately 0.23% of the readings exceeding the NAAQS standard of 9 ppm.

For TVOCs, 3.15% of the Group I (range <0.036–41.04 mg/m³), and 0.49% of the Group II readings (range <0.07–44.25 mg/m³) exceeded Molhave's recommended maximum value of 3 mg/m³.

137

CARBON DIOXIDE LEVELS, RELATIVE HUMIDITY, AND TEMPERATURE AND FLIGHT FACTORS IN COMMERCIAL AIRCRAFT CABINS. M. Waters, J. Deddens, NIOSH, Cincinnati, OH

For the NIOSH/FAA Working Women's Health Study, exposures to cabin environmental contaminants were measured on 33 commercial aircraft flights. One objective of the exposure assessment was to characterize carbon dioxide (CO₂) exposure distributions, temperature, and relative humidity (RH) and their relationship to flight factors such as aircraft size, occupancy, ventilation, and flight length.

Flights ranged in duration from 33 to 851 minutes on 10 types of aircraft. Continuous measurements were made at two locations in the coach cabin from gate departure to gate arrival using direct-reading data-logging instruments. Gate-to-gate mean concentrations of CO₂ ranged from 859 ppm to 2379 ppm. Five-minute time-weighted averages (TWAs) ranged from 664 ppm to 4904 ppm CO₂ and were highest during boarding and deplaning.

Variations in gate-to-gate mean CO₂ levels between forward and rear locations on the same flight ranged from 0.5% to 27%. CO₂ levels were highest on shorter flights, flights with high occupancy ratios, aircraft with air recirculation, and narrow-bodied aircraft. These levels largely do not meet the ASHRAE 62–1989 criteria of <1000 ppm CO₂ for indoor environments; however, they are within the

FAA Federal Aviation Regulation limit for commercial aircraft cabins of <30,000 ppm CO₂.

Relative humidity gate-to-gate, mean levels ranged from 10.1% to 45.6% and 5-minute TWAs ranged from 5.4% to 61.9%. RH levels were lowest on long-duration flights with low occupancy ratios, wide-bodied aircraft, aircraft with no air recirculation, and aircraft operating at higher altitudes. Temperature gate-to-gate mean levels ranged from 22.4°C to 28.2°C, with 5-minute TWAs ranging from 19°C to 29.5°C. Variations in gate-to-gate mean temperatures between forward and rear locations on the same flight ranged from 0°C to 3.2°C, and simultaneous 5-minute TWA temperatures varied even more between locations.

These conditions do not generally meet ANSI/ASHRAE Standard 55-1992 thermal comfort criteria for buildings. However, humidification of this environment is costly and might pose other cabin environmental problems.

138

SEASONAL VARIATIONS IN INDOOR AIR QUALITY MEASUREMENTS IN METROPOLITAN NEW YORK COMMERCIAL BUILDINGS. J. Springston, W. Esposito, J. Liu, Ambient Labs, Inc., New York, NY

Since it is located in a temperate zone, the metropolitan New York region experiences fairly wide climatic changes over the course of the various seasons. In the summer, temperatures are typically in the mid-90s with high humidity, while in the winter, temperatures often range in the 20s and 30s with fairly low humidity levels. Therefore, the varying demands placed on HVAC systems to keep indoor conditions comfortable can possibly contribute to a buildup of various contaminants during certain times of the seasons.

As part of an ongoing proactive indoor environmental quality (IEQ) program, between June 1992 and December 1998, 757 surveys were performed in 125 commercial office buildings in metropolitan New York City. Sampling was performed in "non-problem" buildings, during normal business hours on a quarterly, semiannual, or annual basis. The protocol used for the surveys was based on the EPA's *A Standardized EPA Protocol for Characterizing Indoor Air Quality in Large Office Buildings*. Among the physical and gaseous parameters sampled for were carbon dioxide (CO₂), carbon monoxide (CO), total volatile organic compounds (TVOCs), particulates, temperature, and relative humidity (RH).

More than 19,500 data points were broken into either winter readings, defined as October through March, or summer readings, defined as April through September. The results were then compiled to determine the mean and median readings, as well as the standard deviation, for each of those parameters and seasons. The subsequent graphs were then compared with standards and/or guidelines that are applicable to the indoor environment, as well as to each other.

The results indicated that, not surprisingly, the greatest differences were found between summer and winter relative humidity levels (41.94% RH vs. 28.74% RH). However, virtually no differences were noted between winter and summer CO, CO₂, and TVOC levels.

139

PCB-CONTAINING MASTIC IN VENTILATION DUCTS: A SIGNIFICANT SOURCE OF CONTAMINATION IN A OFFICE BUILDING. J. Kominsky, Environmental Quality Management, Inc., Cincinnati, OH

Following a fire in a high rise office building, it was discovered that significant levels of polychlorinated biphenyls (PCBs) were present on surfaces throughout the building. The surficial concentrations of PCBs were in the range of <1-282 µg/100 cm² (average 7.1 µg/100 cm²), excluding the fire floor, which ranged from <1 to 87,610 µg/100 cm² (average 151 µg/100 cm²). By comparison, these levels exceeded the NIOSH guideline (1 µg/100 cm²) for assessing PCB contamination in office buildings resulting during such incidents. The fire potentially released PCBs (Aroclor 1242) from approximately 28 fluorescent light ballasts.

An initial investigation of the contamination suggested that pre-fire PCB-contaminated fireproofing — and, to a lesser extent, the fire — was the source of the contamination. Further testing (bulk and surface wipe samples) showed that neither the fireproofing nor the fire was the source of the contamination present throughout the building. The source was a PCB-containing mastic used more than 25 years ago in the fiber glass insulation wrap applied to the exterior of high-pressure air metal ducts and a mastic used in the low-pressure air-fiber glass-duct board systems.

The average PCB (Aroclor 1262) content of these materials was 13,366 µg/g and 5814 µg/g, respectively. The PCB was primarily released during the *active phase* (i.e., during installation of the duct wrap and fabrication of the duct board system) through evaporative mass transfer. It was also released to a lesser extent during the *passive phase* (i.e., during operation of the HVAC system) by diffusion and evaporative mass transfer mechanisms. PCB-containing materials (such as adhesives and duct liners) used in HVAC system components may be a significant source of PCB contamination in office buildings.

140

AIR SAMPLING FOR CHEMICALS FROM CARBONLESS COPY PAPER. L. Johnson, C. Schmidt, K. Thompson, University of Florida, Gainesville, FL

In this study, four sampling protocols were evaluated for use in determining airborne concentrations of chemicals from carbonless copy paper (CCP). Gas chromatography (GC) was selected as the measurement technique. To provide standards, samples of the CCP were placed in vials and analyzed by gas chromatography/mass spectroscopy (GC/MS). These samples were then used as standards to determine whether a correlation existed between the use of CCP and chemicals identified in the air at the site.

The sampling was first conducted using bag sampling, but the sample volume and target chemical concentrations were too small for the results to be conclusive. The next attempt consisted of 5 cm by 0.5 cm charcoal, and 50% charcoal and 50% Tenax® tubes. These tubes presented a problem for the laboratory in finding a desorb heater, and created concerns about breakthrough.

The third effort consisted of two 11.5 cm × 0.6 cm tubes in sequence. One of the tubes was filled with charcoal, the other with Tenax. This arrangement provided too much resistance for the pumps. It was determined from the GC/MS results that the

charcoal was not very efficient at trapping the heavy molecular weight chemicals found in the CCP. Sampling with just the Tenax tubes was selected as the technique for the study.

The analysis of the final samples collected for this study revealed a total ion chromatogram similar to that for the standard samples. Comparison of the spectra from the standard samples and the collected air samples revealed that the most significant peaks were the same chemicals in both, indicating that the CCP chemicals were present in the air samples. Only three of the seven CCP chemicals were found in control samples collected at another site, and the amounts of these chemicals were orders of magnitude less than in the target site samples.

141

COOKSTOVE-DERIVED PARTICULATE EXPOSURES TO WOMEN AND CHILDREN IN WEST WOLEGA, ETHIOPIA. D. Dyjack, Loma Linda University, Loma Linda, CA

Inhalation of fine particles has been associated with numerous pulmonary diseases, including acute respiratory infections (ARI). ARI has supplanted diarrheal disease as the major cause of mortality and morbidity among children under the age of 5 in developing countries. Published studies, which quantify open-fire cooking-derived respirable suspended particulate (RSP) concentrations inside peoples' homes in developing countries, are limited in quality and quantity.

To enhance knowledge of exposure profiles, a pilot project was conducted in August 1999 in West Wolega, Ethiopia, using industrial hygiene techniques in the indoor environment. The study included collection of environmental data and 200 in-home interviews to determine cooking techniques. Fifty-three area and personal RSP samples were obtained over a three-week period using the NIOSH Method 0600 on three women who cooked on uncontrolled open fires inside their homes. Ninety-nine percent (n = 197) of interviewed women reported using open fires to prepare food. Forty percent (n = 79) reported cooking inside their dwellings without a chimney or other method to control combustion products. Three- to four-hour time-weighted average (TWA) personal breathing zone samples obtained during afternoon and evening meal preparation ranged from 2.7 mg/m³ to 14 mg/m³, with an average of 7.9 mg/m³. Eight- to 10-hour TWA area samples obtained in the kitchen were in the range of 1.5–12 mg/m³, with an average of 4.8 mg/m³. Twelve- to 16-hour TWA area samples obtained on bedposts to approximate overnight exposures ranged from 1.3 mg/m³ to 20.6 mg/m³, with an average of 9.6 mg/m³.

These data suggest exposures to mothers and their young children are considerably higher than the World Health Organization (WHO) recommendation of 230 µg/m³ for airborne particulate matter. Future studies will employ industrial hygiene techniques to examine concentrations of particulate with an aerodynamic diameter of 2.5 microns vs. those with an aerodynamic diameter of 10 microns.

142

A DESCRIPTIVE ANALYSIS OF CULTURABLE AIRBORNE FUNGI FROM 1717 BUILDINGS ACROSS THE UNITED STATES. K. Kirkland, B. Shelton, G. Morris, PathCon Laboratories, Norcross, GA

This paper presents descriptive data on the types and concentrations of airborne fungi collected during indoor air quality investigations. Fungal samples

AIHCE 2000

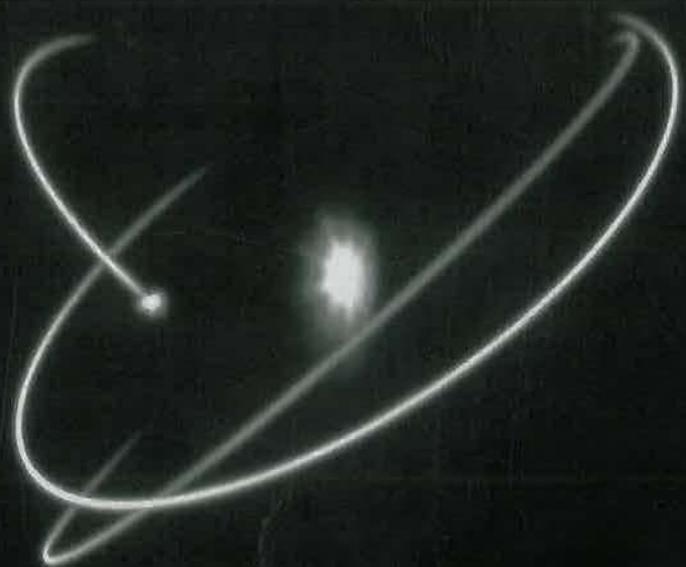


The premier occupational and environmental health and safety conference & exposition

May 20–25, 2000

Orange County Convention Center
Orlando, Florida

Cosponsored by AIHA and ACGIH



PREVENTION —

**Our Mission
for the 21st Century**



Abstracts