

identify areas of concern and communicate corrective actions to building engineers and facility managers. Therefore, the industrial hygienist can more effectively diagnose indoor environmental issues and provide corrective action to correct deficiencies.

205. INDOOR AIR QUALITY INVESTIGATION IN AN AIRCRAFT MAINTENANCE TRAINING SCHOOL.

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An increasing number of complaints of breathing problems, allergies, and adult on-set asthma by instructors and students at an aircraft maintenance school over several weeks generated an indoor air quality investigation requested by the director of training.

Students and instructors were complaining about headaches, lethargy, tearing of the eyes, and scratchy throat. An international student was present and was taken to the emergency room of a local hospital to be checked out. One of the instructors went to the doctor and was told he had similar symptoms to Legionnaire's Disease.

The number of students per classroom ranges from 6 to 15. The curriculum consists of highly technical material.

Four classrooms were the focus of the investigation. The challenge was to determine the source of the respiratory problems and design engineering controls when the source was determined.

The investigation began with looking for a source for Legionella to develop since one of the instructors had similar symptoms, according to his doctor. The components reviewed were HVAC system, plumbing, cooling towers, evaporative condensers, fluid coolers, humidifiers, and direct and indirect evaporative air-cooling equipment. Legionella was ruled out because a source was not available for growth.

Maintenance employees were interviewed regarding the HVAC system. It was learned that each classroom had its own air-supplying unit located in the ceiling. Each unit had a supply air and return located in the ceiling. The evaporative coil units recirculated the same air.

Two outside air units were placed on the roof. The total airflow is 4000 CFM. Each classroom receives 150–200 CFM. ASHRAE states each person should receive between 15–20 CFM of fresh air.

Benefits to industrial hygiene practitioners would be to look at all the possibilities for a problem source. Engineering decisions made in the past can create issues in the present.

206. THERMAL COMPLAINTS AND IAQ.

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"It's too cold" and "it's too hot" have ranked either #1 or #2 in all polls conducted by the International Facility Management Association, whereas poor indoor air quality ranked #6 in

the latest poll. This paper presents an association between the two problems. Thermal concerns have traditionally been the major concern expressed by office employees. Personal experience in hundreds of office IAQ investigations has shown that well-intentioned, but inappropriate, system adjustments made to satisfy thermal concerns often lead to IAQ problems. An improper HVAC system adjustment in reaction to occupant thermal complaints is presented as an initiating cause of many office IAQ problems. The ability to recognize, evaluate, and correct common, but improper, HVAC primary air system flow and distribution problems is proposed as a necessary tool for most office IAQ evaluations.

When thermostat adjustments do not satisfy concerns, the occupant or a maintenance technician may make adjustments that are often based on a rudimentary understanding of system operations. Initial adjustments often involve primary HVAC airflow supply and distribution restrictions. Such adjustments may lead to a temporary correction of the problem in the immediate area. However, experience indicates that such adjustments frequently lead to thermal complaints in other nearby areas. This sequence can then be repeated. Eventually, restrictions on airflow leads to system imbalances, an increase in thermal complaints, an increase in "cold air dumping," a decrease in outdoor air supply, and, eventually, poor air quality complaints.

Commonly encountered adjustments that cause primary airflow restrictions include: reducing VAV box minimum air flows, reducing primary airflow to perimeter fan powered or induction units, blocking diffusers or closing register supply outlets, reducing economizer or outdoor air damper minimum set-points, etc. The ability to assess these problems, as well as "cold air dumping," will be reviewed

207. EVALUATION OF A METHOD FOR DETERMINING AIR EXCHANGE RATES IN OCCUPIED BUILDINGS.

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Outdoor air exchange rate (Q_o) is one of the most critical determinants of room air quality, yet the performance of methods for estimating Q_o has received little attention. Here such a method for estimating Q_o in occupied rooms using indoor and outdoor CO_2 concentrations (CMB method) was developed and refined using simulated schoolroom CO_2 data. It was then applied to actual data collected from two schools.

Simulated data were generated for four factorial combinations: two Q_o values and two emission rate (G) values. The CO_2 mass balance equation was linearized and Q_o was estimated by regression. Refinements considered included: intercept/no intercept, smoothing the

occupancy variable, and selective use of data (entire school day, occupied periods only, and unoccupied periods only, e.g. lunch and recess). The best method performance was found for no intercept, smoothing, and unoccupied room; errors for the four Q_o -G combinations ranged from -4.08 to 0.63% (RMS error = 2.1%). The second-best method performance was found for no intercept, smoothing, and entire school day, which had errors ranging from -6.21 to 0.12% (RMS error = 3.3%). Use of data from the entire school day or from exclusively occupied periods allowed estimates of both G and Q_o , but tended to underestimate both parameters.

The CMB method has several advantages. Estimates represent air exchange over time periods of any length, can be made while the room is occupied, and include the effects of all air exchange pathways. The data required can be obtained easily and unobtrusively.

208. MODELING CONTAMINANT TRANSPORT AND FATE ON PASSENGER AIRCRAFT.

K. Good, Battelle, Columbus, OH.

Like occupants in homes and office buildings, aircraft passengers are exposed to a mixture of outdoor air and recirculated air. However, aircraft occupants experience much higher occupant density and do not have the ability to leave or control their environment. These differences, along with increased air travel, have resulted in increased awareness and concern regarding aircraft air quality. Although numerous studies have examined aircraft air quality, it is beneficial to understand the transport and fate of gaseous or airborne contaminants. For a structure, examining contaminant sources, transport, and removal is often done with multizone modeling, an analysis technique that uses a zonal representation of a structure to estimate pressure differences and the resulting airflow.

In the work presented here, the multizone modeling software CONTAMW was used to build models of narrow and wide-body commercial passenger aircraft. These models incorporated physical characteristics of the aircraft, such as size and layout, and also specific operational characteristics (e.g., airflow rates, mixing ratios) of the environmental control systems. Using these models, the airflow-driven migration of indoor contamination, such as pathogens or odors, from a point source to the rest of the aircraft was estimated. Similarly, the models were used to assess the use of engineering controls to mitigate hazards. For example, using these models to simulate the introduction of smoke into an aircraft, it was possible to examine the effect of filters on smoke concentration and persistence. Additionally, potential mitigation techniques, such as turning off the recirculation, increasing flow of outside air, and venting the cabin were modeled to examine contaminant removal.

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