Table 3 — Water Vapor Permeance and PERM Values for Materials Tested

Sample	Materials	Permeance at 17% RH (kg/s × m² × Pa)	Permeance at 63% RH (kg/s × m² × Pa)	Permeance at 91% RH (kg/s × m² × Pa)
Permeable wallpaper system	1 coat wallpaper primer (water based) 1 coat wallpaper paste (heavy duty) 1 layer permeable vinyl wallpaper	1.30×10^{-10}	2.44×10^{-10}	9.08×10^{-10}
Heavy vinyl wallpaper system	1 coat wallpaper primer (water based) 1 coat wallpaper paste (heavy duty) 1 layer heavy vinyl wallpaper	6.95×10^{-11}	8.47×10^{-11}	2.13×10^{-10}
Latex paint system	1 coat latex primer 1 coat latex flat paint	2.02×10^{-09}	5.26×10^{-09}	8.24×10^{-09}
Elastomeric stucco system	1 layer elastomeric stucco	1.91×10^{-11}	3.39×10^{-11}	2.24×10^{-10}

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CASE STUDY

*[In each issue, **IEQS** presents a case study on an indoor air investigation in a particular building. The information in the cases comes from various sources, including published material, reports in the public record, and, in some cases, reports supplied by the consultants involved in the case. **IEQS** presents a variety of approaches to investigation and mitigation implemented by consultants with a broad range of experience, philosophies, and expertise. Inclusion of a particular case study in the newsletter does not imply **IEQS**'s endorsement of the investigative procedures, analysis, or mitigation techniques employed in the case. **IEQS** invites readers to submit comments, suggestions, and questions concerning the case. At the discretion of the editors, correspondence may be presented in a future issue.]*

Finding Causes of and Cures for Headaches, Draftiness, and Unwanted Odors in a Multistory, Mixed-Use Urban Building

Many occupants of one floor in a five-story, mixed-use building in a large city on the US East Coast made repeated complaints about the building's poor indoor environmental quality (IEQ). None of the occupants had become seriously ill, but many who used a training room for extended periods developed headaches and drowsiness and became lightheaded, reducing their concentration and productivity. Some reported that on occasion a strong odor of fuel filled the air. Elsewhere on the same floor, occupants in open and semi-open cubicles said their workspaces were either drafty or received little ventilation and that the area frequently smelled of food odors. Sometimes they smelled motor-vehicle exhaust even though the building had no windows that opened.

Background

The floor contained about 20,000 square feet. The building heating, ventilation, and air-conditioning (HVAC) system had no economizer, and maintenance workers changed its low-efficiency, flat-panel air filters every three to four months. Managers scheduled the HVAC system to operate between 7 am and 8 pm and to automatically shut off. Building blueprints indicated that the HVAC system supplied 11,600 cubic feet of air per minute (cfm), including 2,900 cfm of outside air, which was adequate for a building of this size. There had been no construction in the last six months, and there were no complaints of mold. The floor with the most complaints generally had about

30 occupants; 15 of them were in the training room the day indoor air experts investigated.

For years, many people who occupied this particular floor had complained about its IEQ, but, due to the nature of their work, they tended to move on after several months. The building owner told the team of two indoor air experts he'd hired that he was unconvinced the building had IEQ problems. The mechanical engineer was new on the job and had little knowledge of the structure beyond the blueprints he handed the investigators and a smattering of anecdotal comments he had heard. The building owner asked the indoor air experts to investigate the complaints and recommend ways to correct any building-related problems.

Investigation

After reviewing the building blueprints, the investigators talked briefly with many of the occupants. Despite their lack of long-term experience with the building, the occupants provided additional clues that ultimately led the investigators to several causes of the IEQ complaints.

Before the trainees entered the training room, one investigator had sampled the classroom air with an infrared spectrometer. It showed a carbon dioxide (CO_2) count of about 600 parts per million (ppm). ASHRAE's current upper limit for indoor CO_2 is 1,000 ppm. The outside air generally ranged between 350 and 400 ppm.

The investigator went to the basement where she smelled a strong odor of petroleum and found several large drums of hydraulic oil No. 32 stored in the open. The drums sat beneath a supplemental air-supply unit that operated only when the building was mostly empty to ventilate a small area that included the classroom. Maintenance workers used the oil in the hydraulic mechanism in the basement that operated the building elevators. The investigator found that the damper for the supplemental air-supply system didn't close tightly and thus allowed hydraulic oil fumes into the system. In addition, a see-through air filter for the system was ill fitting, wasn't pleated, and clearly was of inferior quality.

Meanwhile, outside at the loading dock, the other investigator observed several factors that probably adversely affected the indoor air quality. The outdoor air intake duct, for example, was built into the loading dock where it could easily suck in exhaust fumes from delivery vehicles. The investigator also noted an open dumpster less than two feet from the air intake, and he saw smokers using the designated smoking area near the air intake.

The indoor air investigators also inspected the building's mechanical room where the HVAC system mixes indoor and outdoor air to supply to the building. They discovered that a pin was missing from the air-intake timer, which meant the system operated constantly instead of shutting off at night as they had been told. The mechanical room was dirty, and foul water pooled beneath the air-mixing unit. Years before, someone had installed lead sheeting on the walls to soundproof the room, but much of it had come loose, and several sheets had fallen from the walls. While it seemed unlikely that lead from it could enter the ventilation system, lead does rub off, which meant the sheeting posed a potential serious health hazard. The maintenance staff was most at risk, which was evident from a stepladder casually leaned against the soft sheeting. In fact, the top of the ladder had what looked like lead rubbings on it.

Returning to the training room when it was empty at lunchtime, the investigators saw that the CO_2 level was about 960 ppm, or about 360 ppm higher than when they first measured it. Using a flowhood, the investigators took several airflow readings at different air-supply diffusers and learned that the air-supply system was severely unbalanced. With a Pitot (pronounced "P-toe") tube, the investigators calculated that the air handling units delivered about 1,000 cfm of supply air to the training room. More to the point, the supply air contained only about 20 cfm of outdoor air — just enough for the room to meet the ASHRAE standard if only one person occupied the room. The investigators departed for the cubicle area as the 15 trainees and their instructor returned.

HVAC Issues in High-Tech Startup Area

Moving to the cubicle area outside the classroom, the investigators' measurements showed the HVAC ceiling diffusers there were also widely out of balance. In fact, the measurements ranged from about 40 cfm to more than 600 cfm. This resulted in stuffy air in some cubicles, while in others, the occupants needed sweaters and space heaters to counter a steady, direct blast of cold air. In some cases, high walls blocked airflow into or past a cubicle. Occupants also complained about strong food odors that tended to waft in and linger. When the investigators entered an adjacent kitchenette where the occupants brewed coffee and prepared lunches, they learned why: their smoke-tube tests showed that a diffuser over the food-preparation counter and coffee pot sucked air into the HVAC system and apparently dispersed it into the adjacent cubicles.

Their thermal micromanometer measurements showed that, overall, the high-tech cubicle area received only 14% of the outdoor air its size indicated it should get. Due to its low occupancy rate, however, the investigators calculated that the fresh air it received was adequate. Near the end of the afternoon, they again checked the infrared spectrometer in the training room and found that the CO_2 level exceeded 1,200 ppm.

Recommendations

For the high-tech startup area, the investigators recommended that the building owner have workers reduce the cubicle walls to three-quarters of their original height. Alternatively, the building owner could convert the cubicles to offices and add diffusers as needed. The investigators also recommended adding another fan to pull in more outside air. These steps and balancing the supply-air system should smooth out supply-air disparities in the high-tech area and would also provide the additional outside air necessary to control the CO_2 level in the training room.

In the basement auxiliary air-handling room, the team recommended that the owner build a room around the elevator-hydraulic system and store the drums of hydraulic oil there. This new room would need its own exhaust system. They also recommended installing higher-quality, snugly fitting filters in the supplemental air-supply system.

In the mechanical room, they recommended that the owner have someone upgrade the filters, perform a lead abatement to remove the hazardous lead sheeting, and clean the room regularly.

Finally, at the loading dock, the team recommended moving the dumpster and the designated smoking area sufficiently far from the air intake to avoid pulling in garbage odors and tobacco smoke. The loading-dock crew could ask delivery drivers to park as far as possible from the building air intake and turn off their engines. They also provided an alternative in case vehicular fumes continued to plague the building, which would involve replacing the intake at the loading dock with a new air intake on the side or top of the building where exhaust fumes were less likely to enter.

NEWS, ANALYSIS, AND UPDATES

US EPA, Health Service Say Asbestos Fibers in Zonolite Attic Insulation and Other Zonolite Vermiculite Products Easily Become Airborne

Officials from at least two US government agencies are urging renovators, remediators, home repair specialists, landlords, and homeowners to avoid Zonolite Attic Insulation. Only certified specialists in full-abatement gear with HEPA masks fitted specifically to their faces should handle it after they establish an air lock around the insulated area.

Paul Peronard of the US Environmental Protection Agency (EPA) told ***IEQS*** that fibers of asbestos amid the insulation and other Zonolite products made from vermiculite mined near Libby, Montana, "often aren't bound to the matrix of the vermiculite. The vermiculite insulation itself is crumbly, and in many cases, the asbestos fibers just lay on the insulation unattached, so they're ready to become airborne." (See Figure 1.) He continued, "One glove-box test of Zonolite Attic Insulation generated on the order of 8 asbestos fibers per cubic centimeter (fibers/cc). That's 80 times greater exposure than OSHA [US Occupational Safety and Health Administration] limits allow. We've gotten nondetect results on vermiculite test samples using polarized light microscopy [PLM], but when we looked at the same samples using transmission electron microscopy [TEM], we've found lots of [asbestos] fibers. Some private organizations' tests have found up to 15 fibers/cc in samples of