Another important point to note is that while significant attention is focused on carpets and the role they play in IAQ, other types of floor covering can have an impact also. Simply removing carpets isn't going to eliminate IAQ problems and it's necessary to determine what the tradeoffs are.

For more information on the study, *Airborne Asbestos Concentrations During Buffing of Resilient Floor Tiles*, contact Alva Edwards, Technical Project Officer, Risk Reduction Engineering Laboratory, US EPA, Cincinnati, Ohio, USA.

# CASE STUDY

*[In each issue **IAQU** presents a case study on an investigation of indoor air problems in a particular building. The editorial staff relies on information provided by the environmental consultants involved in the investigation. **IAQU** 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 **IAQU**'s endorsement of the investigative procedures, analysis, or mitigation techniques employed in the case. **IAQU** invites readers to submit comments, suggestions, and questions concerning any case. At the discretion of the editors, correspondence may be presented in a future issue.]*

## VOC Accumulation Causes Problem at Corporate Printing Facility

Inadequate ventilation and poor filtration led to a buildup of volatile organic compounds (VOCs) in the printing department of a US brokerage company. While none of the VOC levels exceeded limits set for workplaces, investigators believe the VOCs were responsible for a long history of symptoms among employees at the facility.

Located on the ground floor of a 10-story office building, the eight-year-old printing facility is adjacent to the loading/shipping dock and an outdoor multi-level parking structure. It connects to occupied office floors, and a major vehicle transit tunnel is nearby.

Two 20-ton HVAC units serve the 4,000-square-foot facility, as well as offices and adjacent service areas. The print shop area, in which 25 people work, receives 16,000 cubic feet per minute of air.

### History of Complaints

IAQ investigators entered the picture in response to several years of complaints from employees and management. Symptoms were similar to those encountered in "sick building syndrome" (SBS) situations, included headaches, dizziness, and respiratory and sinus conditions. Occupants also reported that they smelled vehicle exhaust in the facility.

The investigative team included IAQ consultants, HVAC engineers, environmental consultants, testing technicians, and air pollution control system engineers. The team focused its efforts on the HVAC system and the presence of VOCs and other compounds such as carbon monoxide (CO) and hydrocarbons. Members also conducted real-time air velocity measurements and a physical HVAC systems review.

VOC measurements included three 24-hour monitoring scans following the EPA 624+15 protocol. Test sites were located in areas that would place them near pollutant sources, air supplies, and in worker breathing zones.

### Test Results

Investigators discovered that:

- An outdoor air (O/A) intake was lacking; the systems were operating on 100% recirculation;
- HVAC filters were inadequate for removing VOCs and hydrocarbons;
- The systems were not designed to remove compounds — including VOCs — that are heavier than air; and
- Air distribution rates didn't meet ASHRAE 62-1989.

The VOC tests revealed elevated levels of 1,1,1-trichloroethane, xylenes, and toluene, along with other compounds. Selected results of the tests appear in Table 2. The VOCs were a result of the printing processes being carried out within the space.

Because the area was under negative pressure relative to the outside, vehicle exhaust fumes were entering the occupied zone from the loading/

shipping dock. The photography laboratory, located within the print shop, also showed inadequate ventilation and the presence of VOCs.

The team determined that the minimum ventilation rate prescribed by ASHRAE standards would be insufficient for the pollutants in the space. Team members calculated that 8,000 cfm of O/A — or 50% of the total air supply — would be necessary to dilute the contaminants generated by the various printing processes.

## Mitigation Efforts

The IAQ consultants, following a Phase II engineering study, implemented a number of mitigation techniques to resolve the problems encountered in the study.

They installed four ducted returns located 12 inches from the floor. These were designed to remove heavier-than-air solvent vapors, and included 400 cfm boost fans to assist in the air flow.

Ducts were added to existing passive returns to aid in moving air more efficiently from the workspace to the main return plenum. The team also added 15 passive returns in the suspended ceiling to facilitate the removal of contaminants. Previously, the only such returns were slot fixtures around the fluorescent lights. These, however, were blocked by insulation.

The updated system also included four 2,000-cfm single-pass energy recovery ventilators (ERVs). After heat is extracted from the exhaust air, the air passes through VOC abatement filters. Then, 50% of the return air exhausts to the outside. O/A enters the system, passes through VOC filters, and goes into the mixing chamber. The now-diluted air returns to the HVAC units.

The mixing chamber also includes a passive O/A intake to ensure that the system achieves a 50% dilution rate.

Vehicle exhaust fumes were entering an occupied area adjacent to the loading dock due to negative pressure in the area relative to outside. The consultants installed a 13,000 cfm fan 14 feet above the ground.

Linking this fan to a VOC sensor/controller allowed the fan to operate when VOCs above a certain setpoint accumulated in the area. As levels of VOCs fall below the setpoint, the fan ceases to operate.

**Table 2 — Measurements of VOCs in Printing Facility**

| Compound | Measurement | | |
|---|---|---|---|
| | Test 1 | Test 2 | Test 3 |
| 1,1,1-Tirchloroethane | 47.7 | 81.9 | 27.8 |
| Total Xylenes | 7.9 | 23.1 | 7.3 |
| Benzene | 1.0 | 2.4 | 2.3 |
| Toluene | 21.1 | 57.1 | 18.8 |
| 1,1-Dichloroethene | ND | 2.4 | 0.9 |
| Trichloroethene | ND | 0.5 | 0.3 |
| Tetrochloroethene | ND | 0.2 | 0.1 |
| Ethylbenzene | ND | 4.6 | 1.5 |
| ND = None Detected | | | |

Source: Air Pro Systems

## Photo Lab

The consultants also specified air cleaning equipment for the photo laboratory because of the elevated levels of toluene, 1,1,1-thrichloroethane, and benzenes that were discovered there.

This equipment includes a 1,000-cfm multistage media based system installed flush with the suspended ceiling. This is paired with a VOC sensor/controller. This system, with prefilter, HEPA filter, more than 40 pounds of carbon blend modules, and a room-temperature catalytic filter, provides the room with approximately 40 air changes per hour.

## Results

Post-installation monitoring found nondetectable levels of most compounds, although some methylene chloride and 1,1,1,-trichloroethane did show up. These apparently came from cleaning solvents that were being heavily applied near the testing pumps during monitoring.

The client firm reports that occupant complaints of SBS symptoms have dropped to nearly zero since mitigation efforts were implemented.

Also, the firm has instituted a preventive maintenance plan that includes scheduled filter changes, system diagnostics, and annual testing.

The IAQ consultants involved in this case were from Air Pro Systems and the sensor controllers were manufactured by Perfect Sense, Inc. For more information on the case or the devices, contact David Mandell, Air Pro Systems, 100-8 Patco Court, Islandia, NY 11722, USA; (516) 231-9611, Fax: (516) 231-9633.