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Outlook for Building Systems

The present limitations for KBS diagnostics do not mean that these systems can't be of value in the future. Woods recommends a continuing effort to develop such systems for building planning, design, construction, and operation.

Future developments should include not only building characteristics, but also knowledge bases relating occupant responses to system performance, since it is these responses that often first indicate building problems.

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[Cutter Information Corp. publishes newsletters and reports on knowledge-based systems. If you would like to learn more about KBSs, contact Cutter at (800) 888-8939 or (617) 648-8700.]

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, analyses, 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.]*

Biological Contamination Causes SBS Symptoms in Bank Employees

A contaminated HVAC system accounted for an outbreak of allergic symptoms among the 12 employees of a bank building. Out-of-balance equipment added to the problem by causing hot and cold spots, as well as drafts throughout the office. After an IAQ investigation, bank officials followed the investigators' recommendations to alleviate the problem.

Building and HVAC Description

The branch bank, a 20-year-old building, accommodated 12 employees in 5,500 square feet of space. Customers visited throughout the working day, both inside the building and at a drive-up window.

The HVAC system consisted of a single-duct, draw-through, 10-ton unit. No recent renovations had been done.

Presenting Problems/Complaint History

About eight months before the IAQ investigation, half of the branch's employees began complaining of eye, nose, and throat irritation, headaches, and allergic-type symptoms. The bank's corporate management called in the IAQ consultants to investigate the complaints; this was the first time the building had been inspected.

Investigative Focus

The investigative team included an IAQ technician and a test-and-balance (TAB) engineer. The technician conducted interviews with the building occupants and sampled the air at selected locations throughout the building for bioaerosols, and also measured temperature, relative humidity, carbon monoxide (CO), carbon dioxide (CO_2), formaldehyde, and ozone.

The TAB engineer conducted a ventilation survey and measured the performance of the fan and motor in the air handling unit (AHU), as well as the pressure drop across its components. He also photographed the entire system for later analysis.

HVAC Investigation

The TAB engineer found that the system was completely out of balance. Flow hood and multimeter readings showed that some diffusers were distributing as much as 580 cubic feet per minute (cfm) and some as little as 105 cfm.

Temperatures at the five measured locations ranged from 74.5°F to 75.8°F, and relative humidity from 41%-44%.

In a misguided attempt to prevent motor vehicle fumes from entering the building, occupants had closed the outside air damper. This resulted in a negative building pressure, because more air was exhausted than was brought in.

The fan, plenum, filters, and ceiling diffusers were dirty, and the insulation in the filter bank was beginning to flake. The pressure drop across the coil, however, was only 0.35 inches, indicating that the coil was not significantly dirty.

The low-efficiency fiberglass filters worked better at protecting the machinery than cleaning the air. Air discharge temperature measured 51.5°F due to the absence of a control device.

The system was running at less than full capacity. The engineer determined that a change in the drive package could generate a 25% gain in cfm. Also, the thermostat was out of calibration. While this did not affect system performance, it confused the users.

IAQ Assessment

The air samples taken from the five locations showed no detectable levels of CO, formaldehyde, or ozone. CO_2 levels ranged from 550 to 650 parts per million (ppm), within standards set by ASHRAE and the US Occupational Safety and Health Administration.

Significant levels of bioaerosols were found at all five testing locations (see Table 2). Among those detected were alternaria, aspergillus, cladosporium, sterile hyphae, and yeast. Sterile hyphae are those fungi that did not produce spores, without which analysts cannot determine a formal taxa. Four of the five sites registered microbial levels in the range of 70 colony forming units (cfu). Levels above 10 cfu indicate severe HVAC contamination.

Findings

The investigators determined that the HVAC system was distributing the biologically contaminated air throughout the building, causing the symptoms that the occupants reported. They concluded this from the fact that aeroallergen levels were so high.

Low-efficiency filters and a lack of maintenance cleaning resulted in the system becoming dirty. Rust and debris served as the nutrient base for

Table 2 — IAQ Investigation in Branch Bank Building

Location	Air Flow in cfm	Temp	RH	CO_2 in ppm	Bioaerosols	CFUs
A	580	75.8	42	550	Penicillium	34
					Sterile Hyphae	>75
					Total	>75
B	105	74.6	44	550	Penicillium	>75
					Sterile Hyphae	02
					Total	>75
C	580	75.6	43	650	Penicillium	24
					Aspergillus	04
					Sterile Hyphae	05
					Yeast	01
					Total	>34
D	200	75.8	41	600	Penicillium	>75
					Alternaria	06
					Yeast	03
					Total	>75
E	235	75.0	42	600	Cladosporium	06
					Penicillium	60
					Alternaria	04
					Sterile Hyphae	03
					Total	73

Source: Medical Air Care

the fungi and molds, which in turn had contaminated the systems. The filters were unable to counteract this.

Closing the outside air damper had two effects. First, it reduced the amount of fresh air coming into the building, and, second, it resulted in a negative pressure. This meant that every time the door was opened, unfiltered air was drawn into the building. Infiltration through leaks also proved to be a problem.

The imbalance in the system caused hot spots, cold spots, and drafts. Also, because the system was not operating at full capacity, air moved too slowly over the cooling coil, allowing the air to be cooled too much.

Recommendation for Mitigation

The IAQ team determined that the problems could be alleviated by remedial work on the HVAC system, and recommended the following course of action:

- Clean the AHU, duct work, and diffusers, thereby removing the molds, fungi, and dirt. After cleaning, sanitize the system with an approved sanitizing agent.
- Install high-efficiency carbon filters to clean the air before it enters the system. These filters would eradicate any motor vehicle fumes that enter the building, as well as pollens and spores.
- Open the outside air intake to increase the flow of fresh air into the system and to ensure that the building remains under a positive pressure.
- Change the fan's drive package to increase the total air flow of the system. The increased air flow would be needed to overcome the additional resistance of the new higher-efficiency filters and to solve the low discharge temperature problem.
- Recalibrate the thermostat.
- Install a temperature control unit over the discharge air flow.

The consultants report that all recommendations were carried out.

Conclusions

The problems in the building stemmed from a variety of causes and each fed the other. Dirt in the system provided a breeding ground for microbes, and the imbalanced system added to the discomfort experienced by occupants.

A multidisciplinary approach to the investigation combined all aspects of the IAQ situation and helped the investigators focus on the problem areas.

The investigators report that the mitigation efforts were completed recently. The followup report indicates that the consultants increased the air supply to the building by 47%, raising it from 4,700 cfm to 7,200 cfm. Outside air, which had been 0 cfm due to the closed O/A damper, increased to 1,100 cfm.

The consultants reported that the duct cleaners removed 11 trash bags of dirt and debris from the return air system. Some deposits were so heavy that the cleaners, at one point, had to get a shovel to remove it.

Once cleaning and painting were completed, consultants rebalanced the system to ensure an equal air supply throughout the building. The clients report that they have noticed a significant difference in the quality of the air and no longer experience the drafts and hot and cold spots. They also say the air seems much fresher.

For More Information

The IAQ firm that conducted the investigation and provided the mitigation services is Medical Air Care, a Division of The Penn Air Control Group. Contact Colin Hurren, CEO, Medical Air Care, 5941 Lakeshore Drive, Cypress, CA 90630, USA; (714) 826-8365, Fax: (714) 220-1390.

NEWS AND ANALYSIS

ASHRAE Symposium Brings IAQ Specialists to San Francisco

ASHRAE's *IAQ '92: Environments for People* attracted over 400 people involved in the IAQ industry to San Francisco, California, USA, on October 18-21 for three days of technical sessions on a wide variety of topics, ranging from diagnostic techniques to biocontaminants.

Sessions included panel discussions, technical paper presentations, poster sessions, and ample