tests, and the EPA estimates that drier air was actually delivered.

Anderson said that this attempt at humidification could have led to the creation of aerosolized water droplets in the air, affecting the toxicity of whatever agent caused the results observed in the Anderson mice.

Anderson's staff replicated the EPA's conditions and found the same results as the EPA. However, when they re-aerosolized the water that accumulated in the chamber from the droplets, the mice reacted strongly to whatever was in that water. Anderson said further tests by her lab indicate that whatever chemical is causing the mice to react could be water soluble. She said they had not identified the chemical.

Dyer discounted the difference in the test protocol and said he felt that it wasn't a significant factor. Anderson, however, disagreed, telling ***IAQU***: "When you don't know what's important in an experiment, it doesn't make sense to change a variable."

Dyer said at press time that the peer review panel was expected to have its findings in by the end of the first week in June. Anderson told ***IAQU*** that the peer reviewers "didn't seem hot and bothered" by the EPA's change in protocol, although they did express some dismay at the discrepancy in results.

Whatever the outcome of the peer review, the matter was scheduled to be taken up again June 11 at a US Congressional committee hearing.

Discussion

We wonder why, in something as mysterious as this, the EPA would choose to do anything differently than Anderson Laboratories had done in its original study. The change may not have affected the final outcome, but there's no way of knowing that short of repeating the study under the same conditions as Anderson's original work.

Failing that, the EPA hasn't laid the issue to rest, but has allowed the confusion to continue. Many who originally complained that Anderson failed to present sufficient data may now accuse the EPA of failing to faithfully replicate the study's protocol.

Perhaps the Congressional hearing will shed some new light on why the EPA chose to follow this route, and perhaps we'll see some explanation of how this might have affected — or not affected — the outcome of the study.

For more information, contact Rosalind Anderson, Anderson Laboratories, 30 River Street, Dedham, MA 02026, USA; (617) 364-7357, Fax: (617) 364-6709. At the EPA, contact Dr. Robert Dyer, Health Effects Research Laboratory, MD 51A, US EPA, Research Triangle Park, NC 27711, USA; (919) 541-2760.

PRACTICAL RESEARCH BRIEFS

US Study Finds Low-Cost Measures Alleviate IAQ Concerns

A demonstration project by the US General Services Administration (GSA), which oversees government buildings, has found that inexpensive changes in HVAC operations and better complaint response procedures can go a long way toward improving both the indoor air in typical federal office buildings and the comfort perceptions of occupants.

The results of the project appear in a publication, *Indoor Work Environment Study: Vol. I*, published by the GSA. The agency is planning a followup study to monitor the energy impacts of building management strategies for improved IAQ, to develop techniques for improving communications with building occupants, and to continue the focus on enhanced training and strategies for HVAC operations.

In the current study, the researchers, headed by Ed Light, CIH, and Matt Tyson, the principal engineer, studied four federal office buildings in the Washington, DC, area. The researchers attempted to characterize the four buildings, watch developments as HVAC system parameters were changed, and survey occupants. Their goals were to identify the underlying causes for differences in building ventilation and occupant perception, and to recommend measures for improvement.

During a six-month period, the researchers adjusted HVAC operation in Building 1 and Building 2 to optimize ventilation. Buildings 3 and 4

remained unchanged as controls. Then, they enhanced the complaint response procedures in Buildings 1 and 3, while the process in the other two buildings remained the same. Finally, they increased occupant education in Buildings 1 and 3.

As part of a government energy conservation program, building managers had closed outside air (O/A) dampers under certain weather conditions and had shortened fan schedules. The latter measure meant that the HVAC systems started up too late to achieve comfortable conditions during the morning.

In Building 1, the researchers implemented new fan schedules and increased minimum O/A intake to admit 20 cubic feet per minute (cfm) per person. They increased the HVAC hot water temperature during the winter and balanced the system in one wing of the building.

In Building 2, they also increased the fan schedules and increased the minimum O/A to 20 cfm/person, and activated reheats in the HVAC system.

Some of the changes, they noted, deviated from federal energy conservation regulations, but the changes increased ventilation and occupants' comfort. The researchers indicated that relaxing other energy conservation rules, such as restrictions on humidification and restrictions on simultaneous heating and cooling, could have similar benefits. However, they did not make these changes during the study.

The changes in the complaint response plan in Buildings 1 and 3 included prompt and courteous responses to concerns, onsite measurements, sharing information with occupants, trouble-shooting of system components, and followup sessions with those making complaints.

The occupant education plan was only partially implemented. This included a site-specific memo on IAQ discussing HVAC operation and building conditions. The researchers would have liked to follow this with such things as IAQ seminars and forming advisory committees.

Results

Initially, occupants in all four buildings reported dissatisfaction with their work environments. Approximately half of those who responded to the surveys said that they had been made ill by their buildings. These perceptions of poor IAQ came from a variety of concerns, and researchers felt the concerns were aggravated by poor communications with building managers.

As part of the study, the researchers trained building systems operators in both HVAC fundamentals and strategies for improving IAQ. Building managers reported that the increased HVAC training resulted in more intelligent system operation. Also, the increased training along with enhanced employee communication led to better and more efficient trouble-shooting.

The researchers report that, while accurate information and timely responses were crucial to employee satisfaction, equally important were respecting the occupants' right to be concerned and listening to complaints without being defensive.

Each day, researchers tracked space conditions, air handler performance, and occupant perception in selected areas, and found the following:

- Comparing O/A temperature and supply air temperature provided a good indication of the ability to maintain comfortable conditions;
- Reheat appeared to improve comfort;
- Actual heat and humidity correlated well to occupants' perceptions of conditions; and
- Balanced areas had fewer complaints.

The questionnaire results showed statistically significant improvements in occupant perceptions at Building 1, coinciding with the enhanced building management. Buildings 2 and 3 also showed fewer complaints.

Recommendations

Based on their findings in these four buildings, the researchers made a number of recommendations:

- Optimizing comfort and ventilation — within the capabilities of present equipment — seems to directly affect occupant satisfaction. System operators should keep the building within the guidelines of ASHRAE 62, the ventilation standard, and ASHRAE 55, the thermal conditions standard. Carbon dioxide levels should remain below 1,000 parts per million.
- Complaint response programs should emphasize prompt, courteous, and informative interactions with occupants. Onsite demonstrations of space conditions, along with followup discussions, are helpful.
- Operators should follow a systematic trouble-shooting procedure in response to complaints.

- Operators should receive added training for a better understanding of the system, including the cooling and heating plants and zone distribution equipment.
- Occupant complaints should lead to a mechanical engineering audit, which would include optimizing the system.

Conclusions

Many of the recommendations offered in this study are borne out both by the experience that some building owners have had and by common sense.

In many cases where building owners or managers have resisted occupant complaints and tried to tell them the problem was "all in their head," an adversarial relationship has developed, creating a more difficult situation and leading to a climate of mistrust.

In some of these cases, even when the IAQ problems were subsequently resolved, the occupants' perceptions of poor IAQ continued.

For More Information

For more information on the study, contact Ed Light, CIH, 5534 Johnson Avenue, Bethesda, MD 20817, USA; (703) 242-3424; or Fred J. Sisson, Environmental Management Branch, GSA, 7th and D Streets SW, Washington, DC 20407, USA; (202) 708-5236.

Copies of the report are available for US $89 (US $99 outside North America) from Cutter Information Corp., 37 Broadway, Arlington, MA 02174. Call Karen Kurr, (617) 641-5118 or (800) 964-5118, Fax: (617) 648-1950 or (800) 888-1816.

Swedish Group Looks at Demand Controlled Ventilation

Swedish researchers studying demand controlled ventilation report that both heat loads and carbon dioxide (CO_2) levels can accurately control the amount of ventilation needed to compensate for occupancy. Other measurements, such as relative humidity (RH) and volatile organic compound (VOC) levels, do not provide the necessary control.

The Swedish Council for Building Research conducted the study and reported the findings in a new publication, *D5:1993 Demand Controlled Ventilation*. Authors of the report are Svein H.Ruud, Per Fahlen, and Helena Andersson.

Researchers conducted the tests in a 43 square meter (m^2) conference room with a total volume of 115 cubic meters (m^3). This corresponds to 463 square feet in area and 4,062 cubic feet in volume.

The room is in an interior location with no outside walls and no windows. In use for about eight years, its furnishings are all about the same age. Because of the lack of windows, the lighting system can provide between 160 and 1,200 watts (W), or about the same heat load as is generated by 2 to 16 persons.

The HVAC system, designed for an occupancy of about 20 persons, is separate from the other building systems. Its capacities include heating, cooling, and heat recovery. Temperature and CO_2 sensors placed 1.7 meters (5.6 feet) above the floor control the air flow rate. Normally, the temperature controls the air flow, but when the CO_2 rises above 800 parts per million (ppm), the CO_2 sensor takes over. Air flow rates can vary from 170 to 1,000 m^3 per hour. This corresponds to 100-589 cubic feet per minute (cfm).

The room also contains RH and VOC sensors, but researchers used them only to determine the relationship between their readings and the room occupancy to see whether these sensors would have adequately controlled ventilation.

Researchers conducted a series of 14 full-scale tests, ranging from 6 to 12 hours. They reported on three of those tests because they found the results to be the most interesting. The research team designated the three tests as 7, 11, and 12. In test No. 7, the temperature sensor controlled the air flow, and the CO_2 control never activated. Tests Nos. 11 and 12 indicated how the system responds when the CO_2 levels increase above the set point.

During test No. 7, a two-hour meeting with four persons was followed by a lunch break for one hour and then a meeting with three persons for one hour and a meeting with eight people for 30 minutes.

During the test, the air flow rate never rose above 350 m^3/h (206 cfm), but the CO_2 never exceeded 700 ppm. Researchers considered the air quality and thermal comfort to be good. Test results are shown in Figure 1.