may not be as benign as some believe, and they feel that ignoring the cumulative contribution of outdoor radon exposure, especially among people who spend a great deal of time outdoors, may skew the results of some epidemiological studies.

Daniel Steck of St. John's University (Collegeville, Minnesota) and William Field and Charles Lynch of the University of Iowa (Iowa City, Iowa) conducted the study and report their results in *Environmental Health Perspectives* (vol. 107, no. 2, February 1999).

The researchers measured outdoor radon concentrations at 111 locations in Iowa and 64 locations in Minnesota for three years. At the same time, they measured indoor concentrations in nearby homes. Most radon studies assume that in the US, the average outdoor concentration is 0.4 picocuries per liter (pC/l) and indoors it is 1.5 pC/l.

The researchers found that outdoor concentrations and average indoor concentrations were higher than the common estimates. Table 7 shows the indoor and outdoor concentrations measured in the study. This led the researchers to conclude that epidemiological studies that fail to take outdoor concentrations into account run the risk of basing their results on faulty conclusions, particularly if the subjects spend a great deal of time outdoors in high concentration areas.

Table 7 — Outdoor and Indoor Radon Concentrations (pC/l)

Location	Number of Samples	Geometric Mean	Average	Range
Outdoor				
Iowa	111	0.78	0.82	0.2-1.5
Minnesota	64	0.52	0.60	0.1-1.5
Combined	175	0.68	0.75	0.1-1.5
Indoor				
Iowa	1,039	2.50	3.30	0.2-30
Minnesota	126	2.70	3.90	0.5-33
Combined	1,167	2.50	3.40	0.2-33

Source: Steck et al.

For more information, contact Daniel Steck, Science Center 107, Department of Physics, St. John's University, Collegeville, MN 56321.

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.]*

Multipoint Monitoring Shows Ventilation Effectiveness

This case involves a five-building community college located in an urban area in the northeast US. Several major — and often congested — commuter highways are located near the college, as is a large rail yard. College officials, concerned about the nearby pollutant sources, began a proactive investigation to determine what impact, if any, the vehicular traffic had on the indoor air quality in the five contiguous buildings and whether the school's ventilation system was performing adequately.

Investigators studied the building over six weeks during cold-weather months using a multipoint ventilation monitoring system from AIRxpert Systems, Inc. (Lowell, Massachusetts). In this case, the system consisted of 48 monitoring points inside and outside the building, giving the investigators continuous data on carbon dioxide (CO_2), carbon monoxide (CO), and dewpoint in various locations. These included 12 at the air intakes of the school's largest air handlers, 7 of which are on the roof. The other points were in classrooms, common areas, and administrative offices. During the study, the investigators relocated 2 sampling lines to other locations, giving data on a total of

50 locations. The monitoring system uses a vacuum draw and shared sensor approach that has only a single sensor for each of the parameters being measured.

The aim of the study was to profile the building's ventilation performance over an extended period. Three criteria determined the indoor monitoring locations:

- Rooms with the greatest occupancy fluctuation during the day
- Rooms at the extremities of the air ducts
- Rooms suspected of having ventilation problems

The investigators report that building personnel operated the building as normal during the study and didn't use data to alter system operations during the six weeks. All systems operated as if the monitoring system weren't present.

Results

The monitoring system data, presented in graphical form, shows how the outdoor conditions were reflected in the indoor IAQ parameters. The data collected also indicates that the outdoor conditions weren't predictable. Sometimes, the pollutant buildup from vehicle exhaust appeared at the beginning of the day, and sometimes at the end. The investigators hypothesize that this may have been due to wind direction or other climatic conditions.

According to the investigators, the ventilation system worked well when it wasn't dealing with large amounts of outdoor pollution. When the pollution was extremely high, it's reflection in the indoor conditions was probably unavoidable due to the school's location. The system did show some classrooms with elevated CO_2 levels, although those were still generally within the accepted guideline of 1,000 parts per million (ppm). The following illustrations explain the overall findings.

Figure 1: The dewpoint in the building very quickly tracked changes in outdoor conditions. This figure shows how a weather front that came through the area on December 22 dropped the outdoor dewpoint by nearly 45 degrees within 10 hours. Indoor conditions quickly followed. The two monitoring locations that remained above the others had special systems for controlling their humidity.

Figure 2: On this day, vehicle exhaust elevated outdoor pollutant levels at the school's air handlers only during the morning rush hour.

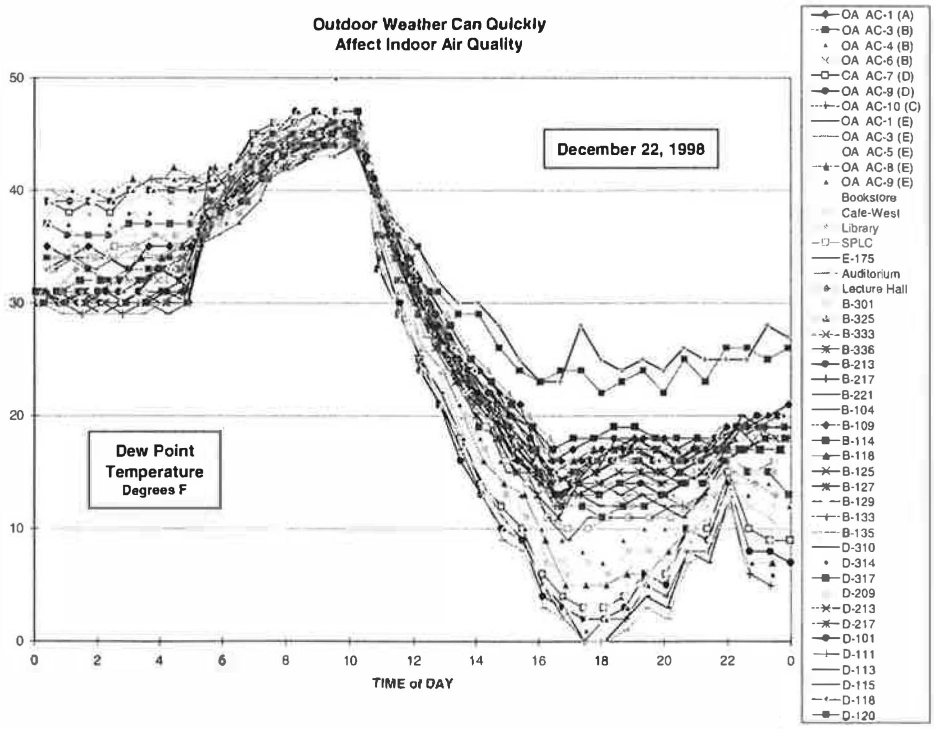

Figure 1 — Impact of Outdoor Weather on Indoor Air Quality, December 22
(©1998 AIRxpert Systems, Inc.)

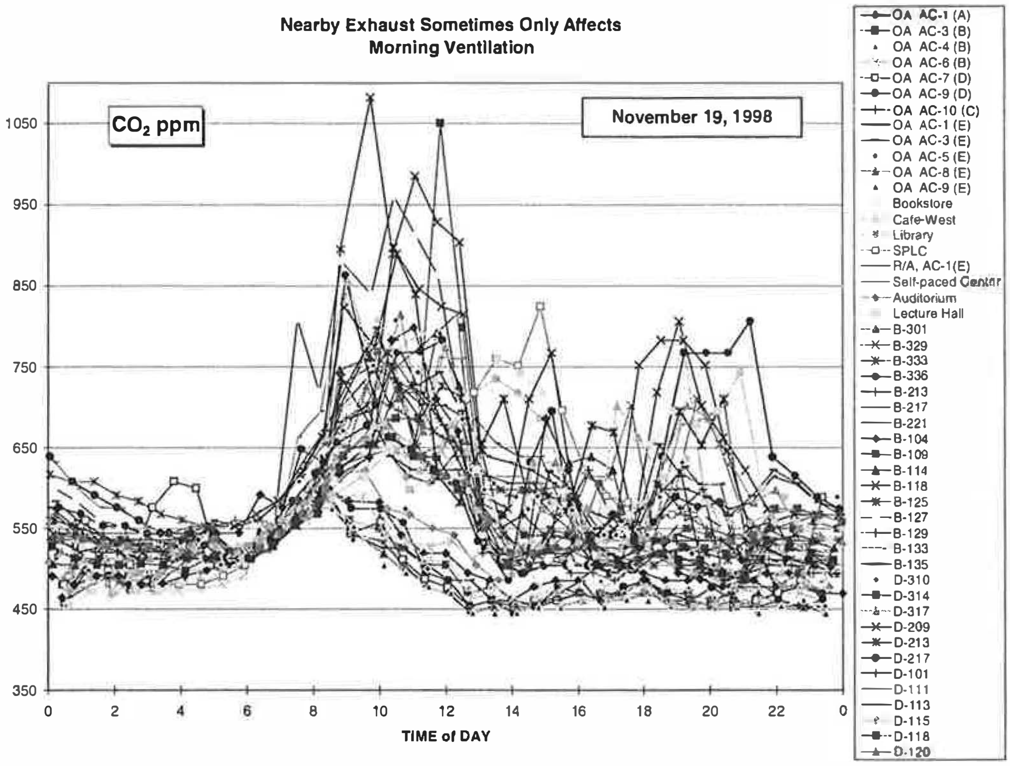

Figure 2 — Exhaust Impact on Ventilation, November 19
(©1998 AIRxpert Systems, Inc.)

When this occurred, all the outdoor monitoring locations showed CO_2 increases of more than 100 ppm at 7:30 am. Indoor locations followed that general trend, as well as showing increased CO_2 concentrations from occupancy levels. The results also indicate that the proximity of the outdoor air intake to the roadway did not matter in terms of the magnitude of the increase in either CO_2 or CO.

Figure 3: On another day, the heaviest impact from vehicle traffic came at the end of the day, with the peak outdoor CO_2 concentrations coming in the 4-6 pm time period. However, even with this elevation, the ventilation system was able to keep all monitored locations — with one exception — at or below 800 ppm. Even the one location that was higher than that stayed below 1,000 ppm. The monitors also showed that CO concentrations, although staying below levels of concern, rose with the increased vehicle traffic. While the CO concentrations were of no concern, the investigators note that their increase might indicate problems from odors associated with vehicle exhaust, and that some of the odors might be irritating to students and staff.

Figures 4 and 5: Because ventilation distribution efficiency can be more difficult at duct extremities, the investigators examined this aspect within the school. To do so, they located 7 sampling points on the third floor of two of the buildings and 15 on the first floors of the same buildings. Because the air handlers for these buildings were on the roof, the air had to travel a longer distance to the lower floors. These two figures show that even though the system maintained ventilation rates within acceptable levels, the lower floors appeared to be not as well ventilated as the upper floors. The investigators suggested that it might be possible to adjust the system to increase lower-floor ventilation by bringing in more outside air. If not, it might be necessary to modify the duct system to achieve the same result.

The investigations also included some areas that had widely varying occupancy levels on a random schedule. For some of these areas, the continuous monitoring showed that the system, while still performing adequately, was at the upper end of its ideal operating range. However, the researchers stressed that the monitoring data should be checked against

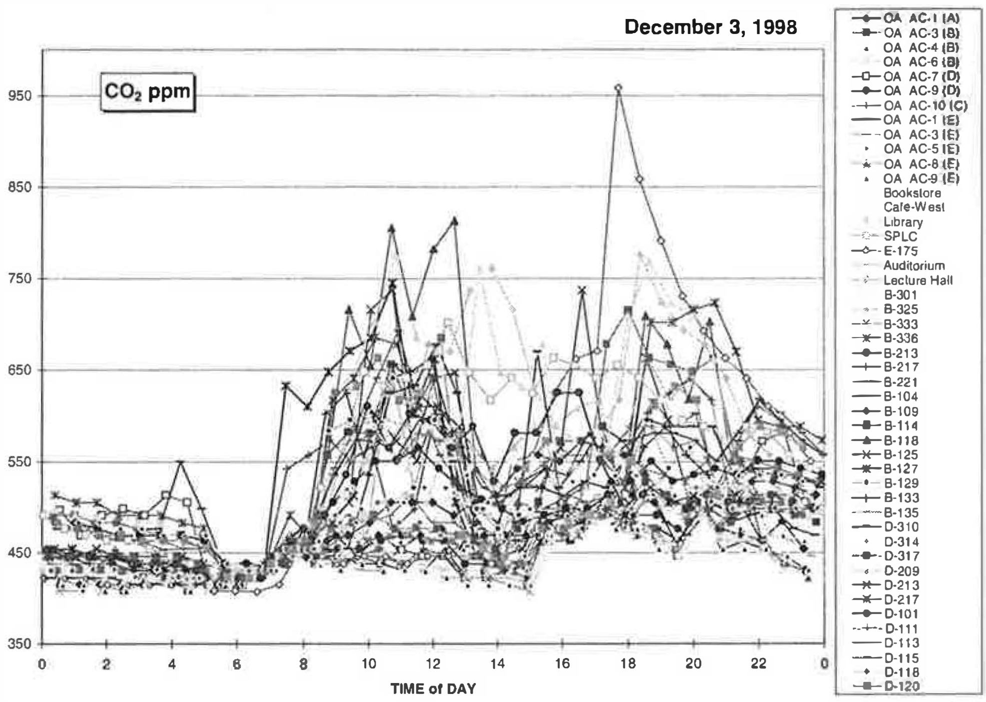

Figure 3 — Exhaust Impact on Ventilation, December 3
(©1998 AIRxpert Systems, Inc.)

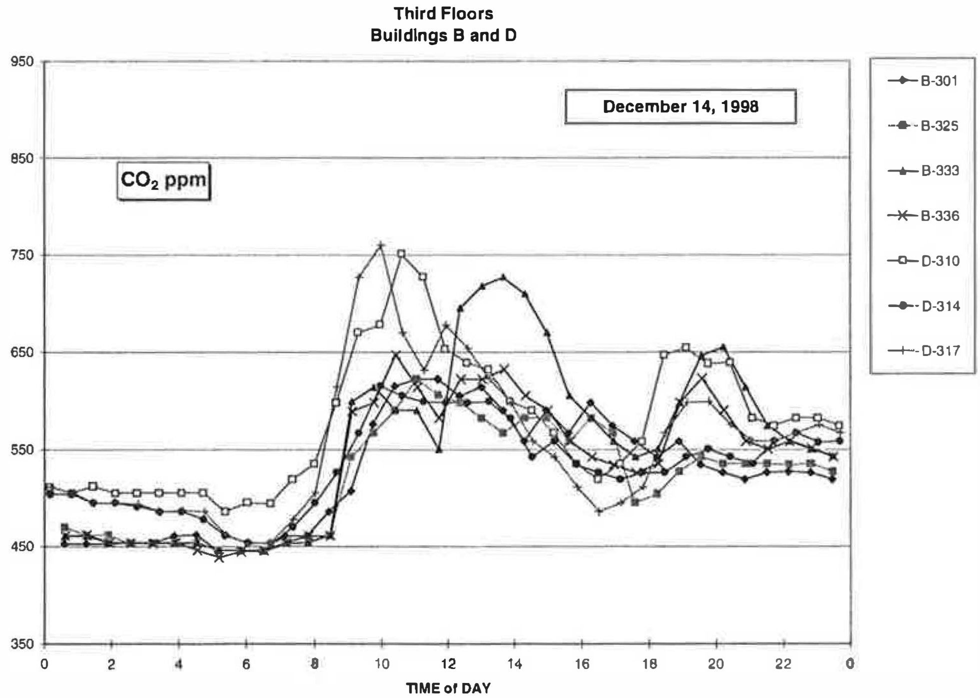

Figure 4 — Results from Third Floors, Buildings B and D, December 14
(©1998 AIRxpert Systems, Inc.)

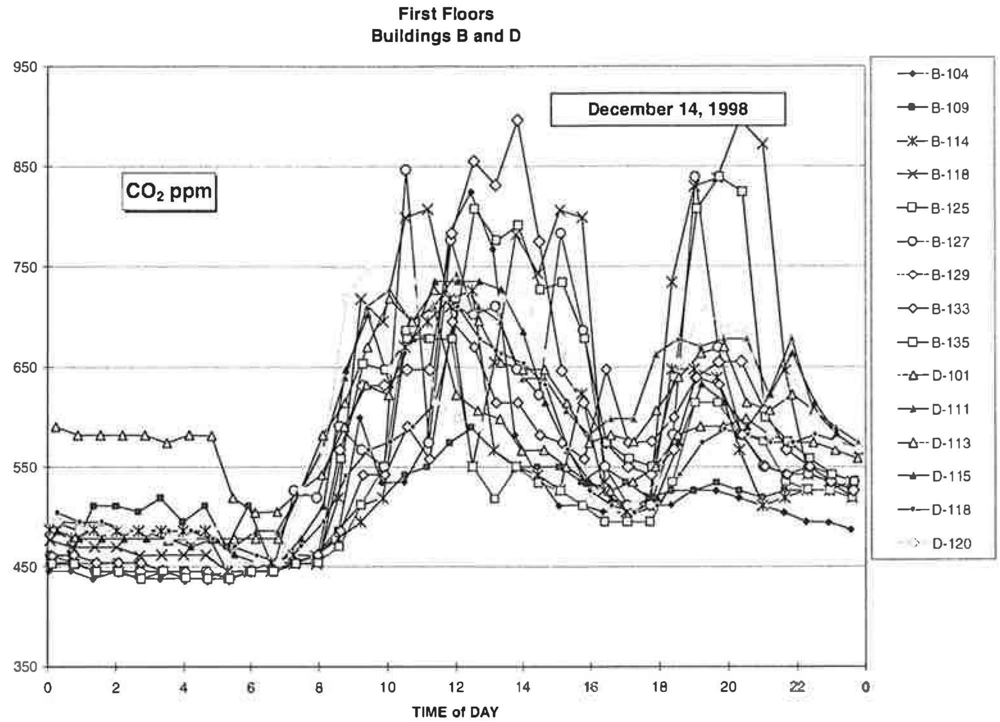

Figure 5 — Results from First Floors, Buildings B and D, December 14 (©1998 AIRxpert Systems, Inc.)

actual occupancy levels to determine whether the increases in CO_2 actually came from additional occupants or from air infiltrating into the space from another occupied space.

Conclusions

As a result of the extended study, the investigators came to three major conclusions:

- Due to the location of the college and the local traffic patterns, exposure to vehicle exhaust is unavoidable and often permeates all building areas.
- CO concentrations are well below federal guidelines, although occupants may notice some unpleasant odors.
- The building's ventilation system appears to be distributing adequate outdoor air to occupied spaces.

For more information, contact David Bearg, Life Energy Associates, 20 Darton Street, Concord, MA 01742. Tel: (978) 369-5680; Fax: (978) 369-0097.

News and Analysis

New Nonprofit Group to Study Building Remediation Issues

A newly formed nonprofit organization will tackle the important issues involved in mitigating environmental problems in buildings. The Indoor Environmental Remediation Board (IERB) will operate under the aegis of the University City Science Center (Philadelphia, Pennsylvania), a consortium of 22 academic and 2 community-based organizations.

Still in the process of incorporation, the IERB plans to develop and define the "best practices" in building remediation, as well as offer certification. While certification is a thorny issue in the IEQ community, the IERB model will differ from the broad IEQ certification that draws fire from many quarters. This difference comes from the fact that IERB will offer certification only for specific functions —