

except to confirm high concentrations. While spot readings can tell us that the concentrations are elevated during the time the readings are taken, they can't indicate the situation over time, which is vitally important in the case of CO, since the health effects are cumulative. They certainly

can't rule out elevated CO levels at another time — even moments earlier.

For more information on the CPSC's efforts on CO, contact Elizabeth Leland, CPSC, Washington, DC 20207, USA; (301) 504-0962.

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 any case. At the discretion of the editors, correspondence may be presented in a future issue.]

Investigators Look to Improve Ventilation in Portable Classrooms

Ongoing complaints among teachers in a California school's portable classrooms have led investigators to suspect inadequate ventilation, especially with carbon dioxide (CO₂) concentrations in excess of 2,500 parts per million (ppm). The mitigation strategy involved increasing ventilation and installing relief vents in the classrooms.

The situation has developed in eight classrooms at the Prado View Elementary School (Corona, California) where teachers have filed a labor grievance over conditions that they claim are responsible for various symptoms, including headaches, sinus infections, and other respiratory complaints, which have been going on for more than two years (see *IEQS*, May 1997).

The eight portable classrooms are arranged in two rows of four each. Each unit is about 25 feet by 25 feet, constructed with steel beams, and pressed wood or plywood. The modular units sit on piers and include a vapor barrier with fiberglass insulation underneath. The walls are also filled with fiberglass. Inside, the buildings have ceiling tiles and vinyl wall covering, but no internal partitions other than some small storage units. The ceiling cavity is about 1.5 feet deep, and plywood and a roofing material covers each unit.

Each unit is designed for 32 students and a teacher. Ventilation and air conditioning come from a wall-mounted reverse heat pump in each unit that operates strictly on thermal demand. When there is no call for heating or cooling, occupants must open doors or windows to receive out-

side air (O/A). The units bring in O/A, but have no exhaust. They rely solely on exfiltration.

According to Steven Uhlman, an industrial hygienist with the county's Department of Environmental Health, the units are arranged in two rows — "like a strip mall" — back to back, with a small alley separating the backs of the buildings. Each row has a bathroom at one end, each with a rooftop exhaust. The HVAC units are located on the side of the buildings that face into the alley.

The teachers began experiencing symptoms over two years ago, and brought the situation to the attention of school district authorities. In addition to the symptoms, the teachers have complained of "rotten egg" odors and have said they have seen mold in the classrooms.

The fear of microbial contamination was heightened by two instances where standing water built up under the classrooms and was pumped out by country maintenance workers. The ongoing complaints led to two building investigations. The first, conducted by a local environmental laboratory, focused on microbial contamination. The second, conducted by the county environmental health department, confirmed the microbial sampling and looked at ventilation.

Microbial Investigation

For the first investigation, school officials brought in Health Science Associates (Los Alamitos, California) to conduct a limited indoor environmental survey, which included:

- Visually inspecting the classrooms for possible microbiological growth;
- Collecting surface spore samples; and
- Performing airborne microbial sampling.

The survey took place over two days in the fall of 1996 in three of the affected classrooms. Investigators took a total of six cellophane tape samples from surfaces in various areas of the classrooms. Locations selected included horizontal surfaces that appeared to be the most likely areas where water intrusion had occurred.

The investigators also took four air samples, one in each classroom and one outside for control. Sampling took place between 3.5 feet and 5 feet above floor level with a total airflow of 150 liters.

According to the report filed with school authorities, the surface sampling indicated only one area with active mold growth. This water-stained area under the cove molding had active Ascospore/Basidiospore growth. Table 1 shows surface sampling results.

Airborne sampling showed levels consistent with the ambient air. Airborne sampling results appear in Table 2. The investigators' report noted the limitation of their study, including the inconclusiveness of airborne sampling, the allergenic properties of nonviable mold spores, and the fact that the sampling was not intrusive.

Ventilation Investigation

In early 1997, investigators from the county health department conducted another evaluation, confirming the earlier results and taking measurements of CO₂ concentrations in the classrooms.

Uhlman told **IEQS** that his sampling showed similar results to those of Health Science Associates, leading him to dismiss microbial contamination

as an obvious cause of the IEQ problems. He said he purposely sought out the dirtiest spots for sampling and had the janitors vacuum the carpets during the procedure.

Some teachers had reported seeing mold in one of the classrooms. Uhlman said the spot in question appeared to be more of a stain in the flooring, rather than active mold growth. He said he also considered the possibility of some incursion from the standing water that had been reported, but dismissed the possibility because of the lack of a contaminant pathway. Also, because the units were under positive pressure — due to air intake with no exhaust — he felt that such an intrusion was of limited concern.

Instead, Uhlman said, he focused more on ventilation, which seemed consistent with the occupant complaints. He placed datalogging equipment in several classrooms and left it there for several days. The readings indicated that CO₂ concentrations had exceeded the machine's limit of 2,500 ppm during the time in question, which would be consistent with the performance of similar classrooms.

Recommendations

In a preliminary report to the school district — the final report is still in progress — Uhlman recommended that the district:

- Rewire HVAC systems to supply a minimum of 15 cubic feet per minute (cfm) per person in each classroom;
- Ensure that units operate continuously while the classrooms are occupied; and
- Install passive exhaust louvers on the classroom walls opposite the HVAC units.

Uhlman told **IEQS** that the district had already begun the renovations, but that they weren't complete when **IEQS** spoke with him, so no fol-

Table 1 — Surface Sampling Results in Portable Classrooms

Sample Location	Description	Results (spores/mm ²)
Room 210	Northeast HVAC wall, on surface of baseboard cove mold, near sink	3
	Northeast HVAC wall, water stain spot on drywall under cove molding	137*
	Northeast HVAC wall, on surface of cove mold, black spot near sink	7
Room 211	Northeast HVAC wall, discoloration on carpet behind computer table	21
	Northeast HVAC wall, surface of HVAC supply air duct	5
Room 212	Northeast HVAC wall, on center window sill	6
	Surface of carpet, discolored spot	17

*Active, fertile colony present

Source: Health Science Associates

Table 2 — Airborne Sampling Results in Portable Classrooms

Location	Time (minutes)	Volume (liters)	Spores/m ³	Spore Type	Concentration (%)
Classroom 210	10	148	1,406	Ascospore/Basidiospore	43
				Cladosporium	37
				Hyaline	14
				Grass smut	1
				Unidentified	1
				Puccinia	1
Classroom 211	10	148	2,855	Ascospore/Basidiospore	66
				Cladosporium	15
				Hyaline	13
				Alternaria	1
				Unidentified	1
				Bipolaris	<1
				Puccinia	<1
Classroom 212	10	147	1,084	Ascospore/Basidiospore	73
				Cladosporium	16
				Hyaline	4
				Agrocybe	4
				Pithomyces	2
Outside	10	148	6,194	Ascospore/Basidiospore	41
				Cladosporium	35
				Hyaline	15
				Unidentified	1
				Epicoccum	1
				Bipolaris	<1
				Agrocybe	<1
				Grass smut	<1
				Dreschlera	<1
				Periconia	<1
				Puccinia	<1
				Stemphylium	<1
				Alternaria	<1

Source: Health Science Associates

lowup studies had been done. When the work is completed, he will verify the O/A delivery to the classrooms and the exhaust effectiveness.

He also said that he had several other concerns with the situation at the school. One concern was the possibility of HVAC units reentraining the toilet exhaust, something he said should be checked once the ventilation situation is in hand.

The other concern is the configuration in which the HVAC air intakes are all located in the alley. He said that while the possibility of reentraining

is small, since the area contains only air intakes, "I don't like the idea of having the intakes mounted in a relatively confined area."

For more information, contact:

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