

November 2000

working environment for eight hours every working day.... Recurrent exposure may be an important factor amplifying symptom prevalence, and future experiments should address this issue."

For more information, contact Pawel Wargocki, International Centre for Indoor Environment and Energy, Technical University of Denmark, Building 402, DK-2800 Lyngby, Denmark.

Tel: +45 45 25 40 11; Fax: +45 45 93 21 66;  
E-mail: pw@et.dtu.dk; Web site: www.ie.dtu.dk.

(The full study paper, "Perceived Air Quality, Sick Building Syndrome (SBS) Symptoms and Productivity in an Office with Two Different Pollution Loads," by Pawel Wargocki, David Wyon, Yong Baik, Geo Clausen, and P. Ole Fanger was published in *Indoor Air* 1999: 9: 165-179.

## 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.]

### Elementary School Is a "Well Building" Again, but Unanswered Questions Remain for Austin, Texas, School Officials

Seven months after severe mold contamination forced the evacuation of 777 students and 77 staff on February 29, 2000, from Hill Elementary School in Austin, Texas, school personnel were finally able to use the building again. Educators and other staff returned to Hill on October 5 after the Austin Independent School District (AISD) spent \$3.5 million to remove mold and renovate the building and its heating, ventilating, and air conditioning (HVAC) system. Only faculty and support staff will use the school this year, however, because the AISD school board bowed to the wishes of most Hill parents last June to move their children to another campus for the 2000-2001 school year.

The \$3.5 million in indoor environmental quality (IEQ) work at Hill includes:

- Abating *Penicillium* and *Stachybotrys chartarum* and other mold contamination
- Gutting and replacing interior walls and ceilings
- Stopping leaks in the roof and building facade
- Designing a new HVAC system
- Replacing all original HVAC ductwork
- Removing the HVAC units, decontaminating them of mold, and reinstalling them
- Adding new HVAC units to help dehumidify outdoor air and to increase the intake of outside air to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards to boost indoor air quality
- Building mechanical rooms under the building to house and protect the HVAC units from moisture that could cause new mold growth
- Venting the previously unvented spring-fed space that contains those HVAC mechanical rooms to reduce humidity

The staff at Hill Elementary School had complained for years about the building's poor indoor air quality (IAQ). Then, early in the 1999-2000 school year, an HVAC contractor doing renovations closed the building's fresh-air intake vents to prevent 100°F outdoor air from entering the air-conditioning system. The vents apparently remained closed until someone discovered the mishap some five weeks later. During those five weeks, at least one teacher, one student, and the principal suffered asthma or asthma-like attacks. As a result, AISD hired an environmental specialist to survey Hill staff. In the survey, more than 45% of Hill teachers said they had suffered headaches, dizziness, nausea, and breathing difficulties. That specialist also collected mold samples. On

September 26, 1999, the school district placed portable cooling units and dehumidifiers in Hill classrooms and launched a three-day effort to remove visible mold and mildew. School officials also hired contractors to assess the school's IAQ and appointed Vincent Torres as Hill Elementary School's IAQ coordinator in mid-October.

Torres, a registered professional mechanical engineer with expertise in HVAC systems, has a daughter who attended the school. Torres reviewed school HVAC blueprints and determined the system airflow and efficiencies. He also inspected the building, sampled CO<sub>2</sub> levels in nearly every room, and collected air samples that revealed high levels of particulates.

"You typically expect to find perhaps 75 micrograms of particulates per cubic meter of air," Torres told *IEQS* last spring, "but Hill had about 400 micrograms per cubic meter."

In late February 2000, school officials closed a classroom that reeked of mold. On February 29, they closed the school after an environmental consultant opened a classroom wall and discovered mold growing inside. Later, investigators found mold growing along the inside bottom portions of the walls of every exterior room in the building. One area of *Penicillium* covered more than 150 square feet (almost 14 square meters).

Ironically, before Hill students and staff began one year of classes at the Lucy Read School in mid-August 2000, AISD personnel learned that the Lucy Read building also had a small mold-contamination problem. The condensation line in an ice machine inside a closet outside the school gym had clogged, causing water to back up and spill into the closet. Several mops against a wall in the closet soaked up the water, and that triggered mold growth in the mops and the closet walls. Those walls were moved and the mold remediated in July. In mid-August, Hill students began attending classes in the Read building and in 17 portable classrooms adjacent to the building. Since that building had housed the school district's professional development center, officials relocated it to Hill Elementary School, opening it for occupancy on October 5, while HVAC and cleanup work there continued.

Some involved in the Hill project had argued that it might be safer and more economical to buy new HVAC units rather than abate the mold in the existing ones, but the construction project's leader believes cleaning the units worked. Contractors moved the mold-contaminated HVAC units outside the building "where you could really see what you were doing, and we thoroughly cleaned them," says David Cooper, project administrator for the Beck Group, the prime contractor overseeing the remediation and renovations. "Assured Air Quality [the Austin firm that first found and sampled the indoor mold contamination at Hill] said the HVAC units looked cleaner than new. There's no question in my mind, we saved the school district money by cleaning the units," he says.

The school district got another break from a dry summer. That allowed the water content of the Hill School concrete footing to decrease from 6% to 3%, which saved \$250,000 budgeted to dry it.

Cooper's team reinstalled the newly cleaned HVAC units in September 2000 and planned to install several new HVAC units in mid-October and then operate them until the end of the month. "We want to allow them to clean out the school air. After the renovation, we cleaned dust above and below the ceiling out of there, but there's always some dust from construction that you can't see. So, we'll run the system for a couple of weeks and change the filters either daily or every other day until we clean particulates from the air."

The HVAC system includes an initial bank of pre-filters with a 30% efficiency rating followed by a second bank of 90% "hospital-grade" bag filters, says Tom Green of Tom Green Engineering, which designed the new HVAC system. The new units will dehumidify fresh air and are designed to prevent the original HVAC units from again being overwhelmed by Austin's typically humid outdoor air. It was that high humidity, along with improper original construction, negative indoor pressure, water leaks in the building envelope, that wallboard that soaked up water like a sponge, and promoted the mold contamination. Poor IAQ, in fact, had plagued the 31-year-old, single-story structure for years.

Green tells *IEQS* that the school will use the 90%-rated filters "probably for a year or two." After

school district officials are confident that the Hill Elementary School building is keeping mold at bay, they plan to replace the 90% filters probably with 65% filters, he says. Green adds, however, "The filtration efficiency should have little to do with the mold contamination in the building, which is more related to what's outside," meaning the mold spores that entered the building on people's shoes or blew in through doors, windows, and cracks.

Regarding the new HVAC filtration at Hill, systems with 30% filters followed by a second bank of filters rated at 60% or higher efficiency are becoming more common in some parts of the US. Filters rated 60% collect 60% of the particulates in air passing through them, capturing particles down to 5 microns in diameter. Mold spores typically measure 5 microns, but broken spores, which remain toxic even when dead, could pass through a 60% filter. Only the most microscopic mold fragments would escape a 90% filter.

### More Work Remains

Cooper tells *IEQS* that completing the mechanical rooms beneath the school "has been a nightmare." The main challenge, he says, was carving footprints for the two rooms — each 90 x 60 feet (27.4 x 18.3 meters) — within the solid substrate of quartzite, limestone, and flint. That space beneath the building slab was cramped in places and is humid much of the time because of the spring.

"We had to use jackhammers, and it was most definitely a difficult job," Cooper relates. "We broke up 20 dump-truck loads of rock down there. But, we wanted to create enough space within each room so the HVAC units in them are easy to maintain. Before, the HVAC units were virtually stacked on one another and were a maintenance nightmare to work on. Now, you can walk down aisles to service the units and filters. The key to good maintenance is to make it easy to do."

Some in the school community questioned the wisdom of having the mechanical rooms in that generally damp space underground. Asked about that, Cooper replies, "I think it will work fine as long as it's well maintained. If they don't maintain it, they'll have problems." He added that both mechanical rooms have fiberglass-reinforced wallboard that is weather-resistant and is typically used

behind exterior stucco. "We will also use a foam sealer that will come down over those walls to further insulate them from moisture."

The Beck Group also plans to install polyurethane foam insulation under the concrete slab the school sits on as a vapor barrier. The investigation team found that moisture under that slab had wicked up into the wallboard from that space, promoting mold growth on the lower portions of those walls. The foam insulation, often used as a vapor barrier on roofs, would help prevent a recurrence. The project team had debated whether to use that foam or a polypropylene "liner" in the subterranean space. The liner, however, would have been difficult to install and prone to damage from maintenance staff who would have had to walk on it. The rubble left behind from the construction of the mechanical rooms there made installation of the polypropylene liner even more impractical.

Before they agreed to install it, however, The Law-Gibbs Group, an engineering division of Law-Gibbs International, studied whether the foam contained volatile organic compounds (VOCs) that might pose an off-gassing problem. Wayne Malik, professional engineer, and senior engineer for Law-Gibbs in Austin, tells *IEQS* that the foam emits "fairly short-lived VOCs, and it's not a significant issue." Most of the off-gassing would happen within "something like two weeks," Malik says, though he didn't recall the exact numbers.

As a precaution for school staff now using the building for professional development training, the construction team hopes to install the foam vapor barrier at Thanksgiving or during Christmas break when educators aren't in the building. Curt Shaw, director of construction management for the school district, tells *IEQS* that the foam probably will be installed during Christmas break. If Beck installs the foam in late December, Malik says, the VOCs would off-gas "long before" students return to the school in August 2001.

As for keeping the mold at bay, Green tells *IEQS*, "The biggest safeguard against the return of mold is the HVAC system design. We have sensors in 8-10 spaces in the building that monitor the temperature and relative humidity. Those sensors 'report' directly to the school district central computer

system. If there's a problem, a digital control system will signal the central computer system." He adds that static-pressure sensors will signal the central computer when its time to change or clean the HVAC filters. The school district should expect to change the 30% filters every four to six weeks, he says. The district can expect to change the 90% filters, and the 65% filters it plans to eventually replace them with, every two to four months, Green says.

### District to Establish Monitoring Protocols, IEQ Program

The school district is developing protocols to monitor moisture levels in the school and maintain the mechanical room beneath it that contains the HVAC units. Shaw says the Texas Department of Health is reviewing the district's draft plan to track humidity levels and IEQ in the school. He says the district plans to develop protocols for maintaining the HVAC system and mechanical rooms.

Another exciting and positive development from the mold crisis, however, is that the AISD school board funded Shaw's request for two full-time IEQ positions. These employees would periodically inspect buildings on the district's 106 school campuses for signs of IEQ problems and would provide an emergency response to investigate any IEQ concerns at Austin schools.

"We're still working on the methodology and job descriptions for these positions," Shaw tells *IEQS*. "We will look at some critical elements and areas that have the potential to produce bad indoor air quality, and we plan to establish a baseline for training and then train the individuals we hire. We'll probably have them investigate some buildings that may get inadequate outside-air ventilation that we want to improve. We'll also have them inspect general maintenance concerns, such as whether air-conditioning coils are being cleaned often enough and if drain lines are getting clogged. These folks would work with our building operators and maintenance technicians to improve general IAQ at our schools. We want these IEQ inspectors to develop a checklist of what to look for at each building. We plan to start by using the [US] Environmental Protection Agency's 'Tools for Schools' kit for guidance on establishing this program."

### Overall, School and Project Officials Earn Good Grades

Austin, therefore, is realizing two positive outcomes from its initially negative and financially costly experience at Hill Elementary School. First, its school officials are applying the lessons they learned at Hill to look for and address potential IEQ problems throughout the district. (See "High CO<sub>2</sub> Levels in Portable School Buildings May Have Implications Far Beyond Austin, Texas" on page 14.) Second, Hill Elementary School apparently is, after eight months, "well" again.

Asked how he would categorize the mold detection and abatement, building redesign, and renovations at Hill, Shaw replies, "Excellent. It has been a great project team. They made good decisions and put tremendous effort into it, and it has been rewarding to work with them. Ask Vince Torres. He was very complimentary about their work, and that made me feel good."

Torres says there are some things he wishes the school district and its team had done differently. He argued, he says, for new windows with thermal breaks to prevent possible condensation that could trigger new mold growth during winter months. Project Engineer Green countered that the HVAC system he designed would be able to handle such condensation. Torres acknowledges that engineers often take different approaches to achieve the same result.

That issue aside, Torres says, "The Beck Group has done an outstanding job of performing the scope of work, and when they identified potential problem areas, they responded by exceeding the contract to prevent such problems. So, the work in the building received high scrutiny and was excellently performed, thanks to the project manager, David Cooper. If I were building a home, I would want David Cooper in charge of the job."

That's high praise indeed from a mechanical engineer with IEQ expertise.

For more information, contact Curt Shaw, Director of Construction Management, Austin Independent School District, 1111 West Sixth Street, Austin, TX 78703. Tel: (512) 414-3151; Fax: (512) 480-0545; E-mail: cshaw@austin.isd.tenet.edu.