SAFETY MANAGEMENT

NUMBER 296 (11)

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A HOLISTIC APPROACH TO "SICK BUILDING SYNDROME"

- *How many people have to complain about symptoms of a problem before you suspect that a problem does indeed exist?*
- *What levels of specific contaminants in a building are necessary before complaints occur?*

These questions have plagued researchers concerned with environmental problems in commercial buildings—a condition better known as "sick building syndrome" (SBS). For years, the absence of statistically-valid baselines of complaints and air quality measurements has impeded the progress of SBS research. However, after almost two decades of research, one company has come up with the answers.

Even before the "energy crunch" was beginning to make its presence known in the United States and Canada in the early 1970's, Theodor D. Sterling Ltd. (Vancouver, British Columbia) was engaged in environmental occupational health and safety research and conducting building evaluations. "We identified problems in buildings related to air quality and inadequate ventilation systems even before the energy crunch started," reports Elia Sterling, Director of Building Research. "We also predicted that the impact of resulting energy conservation programs (such as minimizing air circulation and installing windows that do not open) would be a further deterioration of these environments for people."

Sterling's predictions proved true, as an outbreak of SBS complaints cropped up as companies took steps

to be more energy efficient. Since that time, the company has been a leader in the field of environmental research.

An SBS Epidemic?

By the mid-1970's, the U.S. Department of Health's Centers for Disease Control and NIOSH were becoming involved in building evaluations on a call basis, receiving two or three calls a week. "By 1980, the SBS problem seemed to have reached crisis proportions," notes Sterling. "Environmental experts thought there was an epidemic, because tenants in many buildings were threatening to leave as a result of the problems they were experiencing."

To address the problem, a meeting of international investigators was held to discuss the "sick building syndrome" and to look for similarities among the results of the investigations that they had conducted.

Sterling studied the over 180 source reports and noticed an interesting pattern. "The direction of each particular investigation seemed to focus on what the investigator's chief interest was." For example, if a psychologist conducted the investigation, it tended to focus on stress in the workplace as the controlling factor causing the problems. If an industrial hygienist conducted the investigation, the focus probably would be occupational exposures to particular contaminants. If an engineer conducted the investigation, it usually focused on the building's mechanical systems. There simply was no standard approach to performing building evaluations.

Because of this diversity of problem-solving approaches, there was no baseline of information to indicate the rates of symptoms and complaints one might expect to occur in a building—no baselines for health symptoms or comfort, that is. In addition, there was no baseline for air quality measurement. "If we went into a building and found that 30 percent of the occupants experienced eye irritation, we didn't know whether that indicated a problem or not," Sterling explains. "Or if 30 percent of the people said the air was too stuffy, did that tell us anything?"

To conduct impartial and effective SBS investigations, Sterling knew it would be necessary to develop a set of standards. That meant the firm would need a base of information to operate from.

Developing a Baseline Questionnaire

Using input from Centers for Disease Control investigators and the Columbia University School of Public Health, Sterling came up with a survey questionnaire aimed toward building occupants. "We used it to test 1,200 office occupants in a variety of buildings in the Greater New York area." The nine buildings where testing occurred were specifically chosen because they neither had a history of complaints nor had been designed or retrofitted to be energy efficient. "In other words, we were looking at the 'norm' so we could develop standard baselines," he explains.

The questionnaire, which was machine-coded, was self-completed by building occupants. It covered questions related to:

- Demographic information (education levels, kinds of jobs performed, number of hours worked, number of hours spent in the building, kinds of equipment used).
- Job satisfaction and stress.
- Environment (air movement, air temperature, air quality, odors, lighting, noise/acoustics).
- Office equipment and technology (the use of terminals, ergonomic problems). "The purpose of these questions is to isolate those employees who spend a great deal of time on VDTs," explains Sterling.
- Health symptoms (headaches, fever, dizziness, fatigue, sleepiness, nausea).
- General health. "We wanted to determine if any of the occupants had been diagnosed for any specific problems, so we could separate them from healthy people."

The results of the initial testing of the survey indicated that baselines *could* be developed. "For instance, we were able to determine the normal percentages of people who complained about eye irritation and other problems," explains Sterling. With this information, then, the company could enter a building and determine the percentage of people registering certain complaints; and if these percentages were higher than the baselines they had developed through the original testing of the questionnaire, it was a good indication that the building had some problems. If the percentages were lower than the baselines, then it could probably be safely assumed that the complaints were normal and that the building itself was not the cause of the problems.

To verify the validity of its baselines, Sterling compared notes with questionnaires done in a number of other cities in the United States, Canada, and Europe. "We found the baselines to hold relatively steady in the noncomplaint buildings we studied," reports Sterling.

During an actual investigation of a possible SBS site, Sterling further checks the accuracy of its baselines by performing a study in a nearby "noncomplaint" building. In some cases, for instance, altitude may be a factor in the problem. "By comparing the two buildings in one locale, we can specifically identify what the prob-

SAFETY MANAGEMENT is published monthly by the National Foremen's Institute, 24 Rope Ferry Road, Waterford, CT 06386. Printed in the U.S.A.

lems seem to be, what the symptoms are, and what kinds of environmental conditions exist," states Sterling.

The survey questionnaire is now part of the company's five-phase building evaluation program, which has been published by the American Society for Testing Materials, one of the two major U.S. standards institutes. This is how the program works:

✣ Phase One

A building owner or manager conducts a "walk-through" audit, asking questions of the occupants and recording their answers on a simple checklist form. If specific problems are identified from the checklist, Sterling's investigators move directly to Phase Five.

✣ Phase Two

If the problems are not identified, investigators conduct a survey questionnaire (more lengthy and complex than the checklist) *and* an industrial hygiene inspection, which includes a review of the building's mechanical and architectural information. Again, if the problems are pinpointed here, they move to Phase Five.

✣ Phase Three

Next, investigators take indoor air quality and thermal measurements. "We use carbon dioxide as an indicator of contaminant buildup generated within the building and carbon monoxide as an indicator of contaminant buildup generated from outside the building," he explains.

Carbon dioxide results from human metabolic activity, and if measured levels are too high, it indicates that there is insufficient ventilation throughout the building to remove the excess. "When concentrations of carbon dioxide exceed 1,000 parts per million, you know you have a problem," Sterling says.

High carbon monoxide levels indicate seepage of combustion gases from outside, usually from underground or attached parking garages. "We find such seepage on a regular basis, which indicates that the building codes designed to prevent seepage are ineffective."

Investigators also measure temperature and relative humidity. "We typically don't find many problems related to temperature," he reports. "Most HVAC systems are effective in maintaining consistent temperatures. However, they can 'fall down' when it comes to humidity, which can vary substantially from day to day and month to month."

In 1981, ASHRAE expanded its comfort zone to 20 to 80 percent, which in essence means that there are no humidity standards for buildings, because few buildings ever exceed these limits. "We think these limits are excessive," states Sterling. "Our research indicates that a range between 40 and 60 percent humidity is necessary to ensure comfort and health." The effects of humidity on comfort are obvious, but how does it affect health? Organisms can thrive unchecked in buildings when humidity is above 60 percent, according to Sterling.

"We also measure levels of respirable particulates, which indicate the effectiveness of the building's filtering systems and whether there are any major problems with smoking."

Again, if the building's specific problems are identified in this phase, investigators move directly to Phase Five.

✣ Phase Four

If problems still have not been determined, investigators evaluate the effectiveness of the building's ventilation systems, using tracer gas testing. "We want to get an accurate indication of the actual ventilation being provided, not necessarily what the plans say the system should provide," Sterling explains. "In this way, we can determine whether the system is complying with standards."

✣ Phase Five

This final phase involves the design and implementation of the appropriate modifications indicated by the previous research. That could mean anything from redesigning a ventilation system to taking measures to stop carbon monoxide seepage.

"We have about 400 hard-copy building evaluations we've performed over the years," reports Sterling. "However, we've found that it's cumbersome to do any collating or statistical analysis of complaints, complaint rates, or building types with only the hard copies. To make analysis easier, we've developed a computerized building performance data base, which provides us with a baseline on measurement data. This data base gives us the second of the two baselines we needed. We had the baseline on occupant perceptions, and now we have the baseline on how buildings are actually measured."

When dealing with complaints that might be related to SBS, it's important that you investigate the problem without any preconceived notions about possible causes. That's why it's important to consider a wide range of factors—such as stress, environment, and type of work performed—to make sure you don't jump to any conclusions. Then you can take steps to determine exactly what is causing the problem—or whether a problem actually exists.