Indoor Air Quality Update™

A Guide to the Practical Control of Indoor Air Problems, from Cutter Information Corp.

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SEIU Petitions EPA to Extend Asbestos Rule

In This Issue

"EPA has not created public confidence in asbestos control because EPA has inadequate regulations, virtually no enforcement program, and a totally inadequate monitoring effort for asbestos abatement activities. Lots of illogical decisions are being made as a consequence of EPA's inability to make and adopt effective regulations." So says Bill Borwegen, health and safety director for the Service Employees International Union (SEIU).

On November 10, SEIU petitioned the EPA to at least 1) require adequate inspection of public buildings and identification of asbestos, with communication of the findings to those at risk; and 2) establish required mitigation procedures where a potential hazard exists. The rules SEIU requests should take into account real-world resource limitations and ensure that whatever asbestos control actions are taken are "the most beneficial and least harmful."

The petition, if granted, would result in mandatory asbestos inspection in an estimated 730,000 public access buildings in the United States and, where asbestos containing materials (ACM) are present, the preparation and implementation of management plans. Public access buildings include offices, libraries, public assembly halls (concert halls, movie theaters, convention and meeting rooms, athletic facilities, etc.), stores, bars, and restaurants.

Last year EPA estimated that 24 million people occupy government and private nonresidential buildings and 11.7 million occupy residential buildings (10 units or more per building) that would be affected by the requested rules. ("EPA Study of Asbestos-Containing Materials in Public Buildings, A Report to Congress," February 1988.) The SEIU prepared the petition leading to some of the current EPA requirements on asbestos in schools, and many of its 860,000 union members work in maintenance and custodial jobs entailing substantial and frequent exposure to asbestos in schools and in other buildings.

It's Already Being Done — Badly?

Asbestos inspection and management programs are already being put in place in many public access buildings as a result of pressure from lenders, insurers, and tenants. Where remodeling is done, design professionals' insurance carriers as well as many clients, building owners, and financial institutions are requiring that asbestos be properly considered. When buildings are sold, many of the same parties exert pressures to deal with asbestos.

However, the actions taken in response to these pressures do not always result in proper, adequate, or legal asbestos inspection, management plans, or abatement. There is always widespread grumbling in the construction industry regarding regulation. Many design professionals who are uncomfortable with regulations already in place find EPA's administration of the current rules ineffective.

A principal in one of the largest architectural/engineering firms in the United States told us that he views EPA's inspectors as incompetent and the reporting requirements as excessively burdensome. He suggested that EPA officials are kidding themselves if they think people are going to follow current reporting requirements, implying that his firm does not follow notification requirements for asbestos abatement work in its projects.

SEIU petitioned EPA to extend its rules because of such disregard for rules, the often dangerous improper actions now occurring, and the presence of asbestos in many locations without hazard assessment or management programs.

Challenge to EPA

EPA's challenge is to develop rules that are realistic in terms of private sector resources and behavior as well as its own inspection and enforcement capability. Will EPA find sufficient numbers of qualified inspectors, even if it receives the funding? There is a large demand for such people in the asbestos control industry to perform current abatement work. ***ENR*** magazine estimated that asbestos abatement will be a $100-billion industry in the next few years (see ***IAQU***, September 1988).

When the "purple book" (EPA's "Guidance for Controlling Asbestos-Containing Materials in Buildings") was being revised, many of the people who were involved heatedly debated the requirement of transmission electron microscopy (TEM) for confirming completion and contractor release. Critics argued that there were too few laboratories capable of performing the work, that the delays inherent in waiting for results would be unacceptable, and that the cost would be too high.

In fact, after the issuance of the purple book, many more laboratories acquired the equipment, personnel, and competence to perform the work, and all of the concerns were reasonably well addressed in a rather short time. The increased confidence for making important decisions provided by the TEM requirements has not been evaluated in economic terms. We suspect that in spite of its higher (than light microscopy) costs, it is an economic advantage in the long run due to the tremendously increased reliability of analytical results upon which important abatement project decisions are made.

SEIU's Borwegen told us that if EPA could spend $10,000,000 to $20,000,000 to hire 200 to 300 inspectors who could effectively implement EPA rules and regulations, we could save billions of dollars by restoring public confidence in asbestos control and avoiding unnecessary and haphazard abatement.

According to Borwegen, "There is no level playing field; a lot of illogical activities are being conducted." He says that what is needed is a set of regulations saying when abatement is necessary; control or management programs would be adequate in most cases. A lot of unnecessary (and sometimes improper) abatement is occurring due to the lack of such regulations.

"It's about time that the EPA took a leadership role in this country. It's time that the EPA, for once in its history, took the lead, instilled public confidence," Borwegen said. "EPA has got to instill public confidence in order to avoid tons of misery and the waste of billions of dollars. EPA must get their act together!"

Regardless of whether asbestos removal or management programs are warranted in terms of the risks of exposure and the costs of control, we agree with SEIU that every one would benefit from a clear, reasonable, enforceable, and enforced set of rules and standards. ♦

ASHRAE Ventilation Standard Appealed

The long-awaited ASHRAE Draft Standard 62-1981R, "Ventilation for Acceptable Indoor Air Quality," has been appealed, and the appeals will be considered at the upcoming ASHRAE Winter Meeting in Chicago, January 28 - February 1 (see Calendar for more information on the meeting). As a result, it is not expected that the standard will be adopted this month. Instead, it is more likely that the adoption will occur sometime this spring.

As we have written in ***IAQU*** before, we think the impact of the standard will be tremendous, although it is likely to be several years before it is fully implemented in most buildings. We will follow events in Chicago and report them in the next issue of *IAQU*. ♦

On the Horizon

Freddie Mac Proposes New Environmental Inspections

On November 4, the Federal Home Loan Mortgage Corporation (known in the industry as "Freddie Mac") issued a "draft of proposed guidelines" that would require environmental hazards evaluation for one- to four-family mortgages it purchases on the secondary market. Primary lenders selling loans to Freddie Mac would have to meet standards of due diligence in determining whether hazards such as urea-formaldehyde foam insulation, radon, or asbestos are present. Similar guidelines are contemplated for multi-family (more than four units) loans.

These guidelines are in line with trends in the lending industry, including due diligence guidelines for assessing environmental hazards in multi-family loans purchased by the Federal National Mortgage Association (Fannie Mae). And Fannie Mae is said to be contemplating single-family guidelines as well.

This sort of action means more inspections, more discovery, more clean-ups, and more purchaser consciousness of indoor air quality and other environmental concerns. This is another example of how the private sector will act when state and federal governments fail to do so.

The kind of inspections to result from these guidelines are not likely to differ significantly from structural pest control ("termite") inspections now required at point of sale for older properties.

We have participated in a program to develop earthquake hazard mitigation inspections and remediation for older wood-frame dwellings in California. The costs of significant improvements are often small, and they are most easily made when they can be included in the long-term financing. Based on the popularity and success of that program, we believe similar kinds of programs can and will be developed for indoor air pollutants and other environmental hazards. ♦

OSHA Developing Guidelines for Indoor Air Investigators

OSHA is preparing guidelines to assist its investigators in studying indoor air problems. The document is expected to be completed by summer and will give OSHA field personnel information on commonly encountered indoor air problems. It will assist them in quickly determining compliance with OSHA regulations without discounting the possibility that problems may exist that contribute to elevated complaint or symptom levels.

In the past, many investigators have used OSHA standards to interpret indoor air measurements. In nearly every instance, measured concentrations are below OSHA standards. The results are reported to building operators and occupants in a manner that does not make clear the difference between occupational exposure limits and the known or potential health and physiological effects of exposure to lower concentrations.

The typical report often has therefore given building operators a misleading impression that there is no "real" problem in the building. This leads responsible parties to conclude that the occupants are complaining for other reasons, and hostile interactions often ensue. The document under development is intended to provide OSHA compliance information without discounting the potential for building related problems at sub-OSHA threshold concentrations.

The OSHA Health Response Team staff in Salt Lake City is currently collecting information from the many existing documents such as NIOSH (see page 12 in this issue) or the Maryland Department of Education (see *IAQU* Premier Issue, May 1988). After internal review and agency approval, the document will be available to OSHA personnel and interested members of the public.

For more information, contact: Edward Zimowski, OSHA Health Response Team, 1781 South 300 West, Salt Lake City, UT 84115; (801)524-5896. ♦

From the Field

Is There a Trend Toward More Lawsuits?

We have no statistics on the number of lawsuits filed on indoor air quality, but based on the phone inquiries we are receiving, we believe that the number is increasing rapidly. Coverage of indoor air issues in the general press and especially in the legal press has increased attorneys' awareness of IAQ concerns. Apparently many architects, engineers, product manufacturers, and building owners are also becoming increasingly aware of the potential for legal action and are taking defensive action.

Design professional journals (architecture, engineering, and interior design) have run articles by attorneys advising their readers on limiting liability. Generally they are urging design professionals to recommend that the client retain an indoor air quality or indoor pollution consultant. When the clients hire indoor air quality consultants, they do not want to directly supervise the work of the consultants; they want the work run through the design professionals as part of the design services.

Professional Liability Insurer's Advice

A prominent Northern California insurance broker specializing in professional liability insurance distributes a monthly bulletin, "The Professional Liability Perspective," to its clients. In the June 1986 issue the topic was indoor pollution. The bulletin advised design professionals that "the potential liability problems posed by indoor pollution are compounded by the fact that the pollution exclusion in your policy of professional liability insurance is all-compassing. It extends to every form of environmental contamination imaginable. The risk is simply not insurable."

The bulletin goes on to suggest that the owner stands to profit from the development of a successful building, and *the owner "ought to take most of the risks involved."* And later, *"Be candid about the limitations of your ability to deal with health aspects of buildings."*

After taking whatever measures you can to minimize indoor pollution, *document the measures you are taking and recommend that the owner retain a qualified air quality consultant.* The bulletin says designers should also recommend " 1) that the mechanical system be balanced and fully operational prior to occupancy; 2) that the system be operated at an accelerated level for an initial 'break-in' period; and, 3) that air quality be tested prior to and monitored during initial occupancy of the building. If your client refuses, you will at least have your recommendations on record in the event the 'sick building syndrome' should emerge later on."

Finally, the bulletin advises: "Indoor pollution is seen by many close to the profession as something of a new frontier for the underemployed at the plaintiff's bar. Your challenge is to take steps to remove yourself from the path of the almost inevitable stampede. You can do so if you heed and act upon the early signs of danger on the horizon."

Lawyer Advises Caution

This advice is not new. Similar recommendations recently appeared in the November 1988 issue of ***Contract***, a monthly magazine on office interior design, and in the September 1985 ***Architectural Record***. Both of those articles were written by attorney Larry F. Gainen, who recommends careful definition of responsibility for indoor air quality, retention of a qualified indoor air quality consultant, and documentation of any client decisions that might result in potential indoor air quality problems.

Gainen also recommends testing a building before occupancy. We do not think air quality can be adequately predicted from pre-occupancy measurements. Such measurements can identify problems with ventilation system operation, and this is worth the effort involved in some sort of pre-occupancy testing program. But the absence of clear evidence of indoor air pollution during pre-occupancy testing is not sufficient to ensure that problems will not surface later.

You must test after occupancy and periodically during the life of a building if assurances of indoor air quality are desired or required.

Building Industry Responses

Many building owners and design professionals are seeking professional IAQ advice. Architects are seeking assistance with HVAC system design, shake-down, and commissioning, as well as with the selection of building materials and furnishings with lower emissions of harmful or irritating chemicals.

Engineers are considering more efficient filters or air cleaning equipment capable of removing gaseous contaminants. They are also beginning to reverse the recent trends of using fiberglass ductboard and of reducing system design capacities to save money during construction and operation.

Interior designers are looking for "safe" finish and furnishing materials and guidance on their installation. In many cases they are responsible for extending the HVAC system from central distribution to outlet or return grills, and they are seeking advice there, too.

Building owners are asking for expert help to review plans and specifications for buildings during design and to evaluate building performance before occupancy or during initial occupancy periods. New leases prescribe more precisely ventilation system operation hours and conditions, the costs of additional hours of operation, and the limits on tenant activities which might produce air pollutants.

Tenants are looking for help in dealing with all of the above issues, but in a manner that best protects their interests. In particular, they are looking for help in developing leases and in overseeing the design and installation of their improvements.

Product manufacturers are interested in reducing their liability, in gaining a market advantage through developing and marketing "clean" or "safe" products, or through developing new products which control and eliminate sources of indoor air pollution.

And Attorneys React

Attorneys are likely to consider a variety of legal actions in response to IAQ problems — to bring about improvements in the building, to recover damages for lost productivity resulting from illness, or to obtain damages for harm to occupants' health.

In the short run, this means more time spent dealing with lawsuits. In the long run, we see the impact on indoor air quality as being beneficial. It is costly to address these problems through the courts, and some cases are being handled in arbitration. In many instances, professional liability insurance companies are telling their policy holders to settle (for the amount of their deductible, sometimes $100,000 to $250,000).

Building design professionals' clients expect good air quality without having to pay extra for it. And it is understandable that they do. But architects and engineers capable of utilizing state-of-the-art methods and knowledge to address indoor air quality issues are rare — practically nonexistent. It may take several years before the knowledge being acquired by researchers and indoor air specialists becomes fully integrated into normal design services. In the meantime, architects will have to recommend, and their clients will have to pay for, indoor air quality specialists for their building projects.

The ASHRAE IAQ Standard

The soon-to-be adopted revised ASHRAE Standard 62, "Ventilation for Acceptable Indoor Air Quality," could have a major impact on the design professions and on building environments. The draft of the standard calls for a number of fundamental changes:

- in documentation of design assumptions
- in careful selection of materials to eliminate sources of indoor air pollution
- in specifying criteria and guidelines for air quality, and
- in requiring that minimum outside air quantities be delivered to an occupant's breathing zone.

Many jurisdictions have referenced ASHRAE ventilation standards, and professionals are increasingly proceeding at their own peril when they ignore such standards in their practice. Building owners and operators are also running the risk of litigation when they use building codes or other guidance rather than the ASHRAE ventilation standard.

Reducing Liability

We think the advice given in the bulletin and the two magazines mentioned above is sound. We would add that the burden of clearly communicating the importance of IAQ and the way it should be handled in design is squarely on the shoulders of design professionals.

Architects, engineers, and interior designers should define the IAQ services they recommend to their clients, identify professionals who can perform them, and notify their clients when problems are likely to arise due to the absence of such services.

Preparing/Defending Lawsuits

In our experience, many attorneys involved in IAQ-related litigation fail to appreciate the importance of the medical evidence and the health science theories. They believe that simply because there were defects in the building and their clients suffered health or other harm, there will be no problem in presenting an effective brief.

We believe that medical diagnoses alone are *usually* insufficient to demonstrate a probable cause in the building. Qualified experts in toxicology, immunology, allergy, or other specialties must identify a plausible mechanism to connect the diagnosed health problems to the building environment. Preparing a case for either side must be based on a three-part argument consisting of 1) clinical confirmation or diagnoses of health problems, or epidemiologic evidence 2) health science theory of causality, and 3) demonstrable environmental exposure resulting from occupancy of the building. ◆

Jean Mateson's IAQ Experience

Jean Mateson of Mateson Chemical Corporation (see Products & Services) does lots of consulting on problems in buildings, particularly after fires, explosions, spills, sabotage, or other accidental contamination. When we interviewed him recently, we found him to be a rich source of interesting experience, some of which follows.

1. Most engineers downgrade the air filters in the buildings they design in order to save capital and operating costs. This is the first mistake, and an important contributor to many IAQ problems.

2. Using charcoal filters to deal with VOC often results in distribution of charcoal throughout the building. In one hospital, a volatile chemical was found throughout and modular charcoal panel filters were installed. The charcoal unloads, distributes down the HVAC system, and is visible around the diffusers. It may be mistaken for soot, but it is not. The right type of charcoal panels must be selected and installed correctly.

3. Prefabricated fiberglass duct board is widely used, particularly in the sunbelt where builders are eliminating metal ducts to fight unions.

   Mateson is seeing increasing degradation of the ducts. Migrant fiberglass is often seen on the steam heat exchanger coils; it usually comes from sound insulation in the ductwork. A fine powder is seen and when viewed under a microscope can be confirmed as fiberglass. It comes loose from a number of causes:

   - Mildew and bacteria strains will develop in the ducts over time, and these micro-organisms will eat the formaldehyde in the binder.
   - Cutting into ducts during construction or remodeling to install sensors or wires will loosen fiberglass.
   - Vacuum cleaner trucks (25,000 CFM) are used to clean ducts and they can easily disturb the integrity of the fiberglass.

4. When investigating a building air quality problem, first visually inspect, then test for emissions from the ventilation system itself. This is often very enlightening.

5. Silicates (sodium silicate compounds) — "water glass" — are often used to encapsulate asbestos and other fibrous materials; when they dry and become brittle they eventually degrade into the powder they started out as. When the air is analyzed, these materials will be found.

6. Steam humidifiers are introducing amine compounds (rust inhibitors) in the air, and these are toxic air contaminants.

For More Information

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Dust Mites

According to an article in the February 1989 ***Practical Homeowner***, dust mites are everywhere, at least in our homes. The article indicates that millions of the microscopic critters inhabit virtually every home, and that their airborne feces are the most common foreign protein inhaled from home air. According to Professor Thomas Platz-Mills of the University of Virginia Medical School, 10 to 15 percent of the population has developed allergy because of constant exposure to dust mite feces.

The common dust mite is difficult to eliminate from the home environment, particularly from carpets and thick fabric upholstery. Control of humidity and temperature can reduce dust mite populations, but they are virtually impossible to remove from bedding or thick pile carpeting.

Careful and dilligent maintenance of humidifiers and dehumidifiers is essential to controlling dust mite populations. And discontinuing use of humidifiers during the winter is an excellent way to knock their populations way down. Cool homes may have fewer problems than warm ones, according to the article, especially where humidity levels are also kept low.

We have not read or heard of dust mite problems or control in nonresidential buildings. If any of you have information to share with us on the nonresidential occurrence of dust mites, please send it to our editorial office.

For More Information

"Dust Mites," ***Practical Homeowner***, February 1989, pp. 18-21. ◆

Practical Research Briefs

VOC "Patterns" in Sick and Healthy Buildings

Investigations of sick building syndrome (SBS) or other occupant complaints may involve extensive — and expensive — air quality measurements. These measurements usually fail to identify the causes of the complaints and thus do not point to effective remedial measures. Sometimes investigators obtain large amounts of data from air sampling, questionnaire surveys, or other environmental measurements. But unless they can identify patterns in the data that suggest possible causes, or at least directions for further investigation, their measurements are useless. In this article we describe the results obtained in a Swedish study by Elliot Noma and his colleagues. They employed a sophisticated statistical technique that may identify patterns of air pollutants in buildings where sufficient measurements of chemical concentrations or other relevant data are obtained.

A recent article in the journal ***Atmospheric Environment*** describes Noma's application of correspondence analysis to chemical concentration data from one sick and one healthy Swedish preschool. The results have important implications: the researchers may have found some clues to causes or indicators of sick building syndrome, and they certainly have demonstrated a valuable way to analyze chemical data. We think the technique used could be beneficially applied in investigations of sick buildings, in indoor air audits, and in pre-occupancy monitoring of new or remodeled buildings.

Background

In many other studies of sick building syndrome, differences of chemical occurrence and concentrations between sick and healthy buildings have been investigated in the hope of finding specific chemicals present in sick buildings and absent in healthy buildings. Yet no consistent pattern has emerged from such studies.

In this study, the researchers not only measured chemicals present in the two buildings, they also compared selected locations within the buildings. They compared the gross chemical levels between buildings and also the distribution of chemicals within the buildings. This "within-building" analysis of variation is useful in assessing the effects of people within spaces and of ventilation system components on the air chemistry within a building.

The Study

1. The researchers analyzed data from two identically constructed Swedish preschools, one known to be a "sick building" and the other a "healthy building." 170 air samples collected at 17 locations inside and outside the two schools were analyzed for volatile organic compounds (VOC) by GC/MS (gas chromatography/mass spectrometry).

2. On all 170 gas chromatograms 158 peaks were defined. Of these, 33 VOC could be positively identified and quantified by GC. These compounds were typical of those found in many indoor air studies (such as the EPA study reported in *IAQU*, December 1988).

3. The locations were chosen to represent distinct spatial volumes within the schools, with emphasis on locations where differences in the heating and exhaust systems might be important.

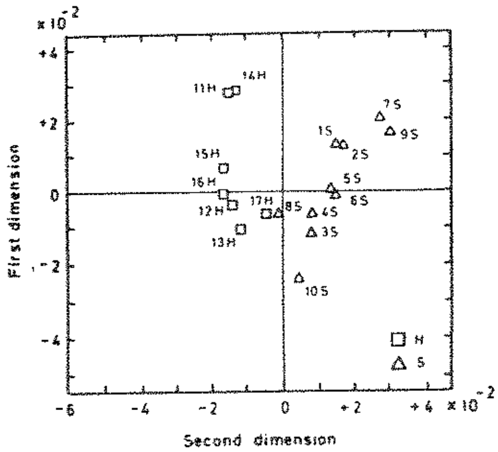
4. The relationships between the chemical concentrations and their locations in the two preschools was represented spatially by correspondence analysis and other statistical techniques to determine the "patterns" of occurrence.

Correspondence Analysis

According to research collaborator Elliot Noma, correspondence analysis was first developed in 1941, and seems to be lost and rediscovered every five years or so. He has applied it to the data available from the investigations of the schools.

The technique involves simultaneously representing chemicals and building locations as points in geometric space. Correspondence analysis places each chemical as close as possible to the location where it has the highest concentration. This is done by arbitrarily placing all the chemicals in the space and then placing the building locations close to the chemicals congregated at that particular site. Then the locations are used to rearrange the chemical positions (on the spatial plot) so that they occur as close as possible to the location of their highest concentration. The process is repeated until a stable position for both chemicals and locations is achieved (by computer, of course).

According to Noma, the key is that correspondence analysis allows one to see which locations have



Location #	Location Name	Location #	Location Name
	S Locations		*H Locations*
1S	Supply air before heat exchanger	11H	Outdoor air
2S	Supply air after heat exchanger	12H	Exhaust air — room
3S	Exhaust air before heat exchanger	13H	Exhaust air — staff room
4S	Exhaust air after heat exchanger	14H	Supply air in ventilation system before fan
5S	In the room at ceiling level	15H	Supply air in ventilation system after fan
6S	In the room at floor level	16H	Exhaust air in ventilation system on roof
7S	Outdoor air at building S	17H	Exhaust air — room, transferred to mobile laboratory adjacent to the building
8S	Room air — with persons in the room in S		
9S	Outdoor air at building C		
10S	Room air — with persons in the room in C		

Figure 1

similar chemical profiles and also permits a grouping of chemicals. Comparing the plots of the chemicals and the plots of the locations, one can easily see which chemicals have the highest concentrations in which locations.

Results and Interpretation

In Noma's analysis, chemicals and locations are plotted within a "common space." To clarify the presentation, the building locations and the chemicals are shown in separate plots (Figures 1 and 2 respectively) although they actually occur in a common space created by the correspondence analysis.

For the non-statistician, it is less important to understand the process by which the analysis is done than to examine its results. For the statistician, the published article contains more methodological details and some references which describe the statistical techniques that were used.

Very clear patterns emerged for "within building" and "between building" plots. These patterns show significant differences between the sick and the healthy building.

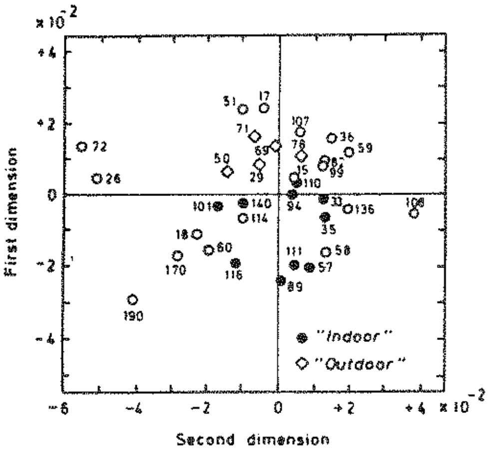
Figure 1 is a two-dimensional plot (from the correspondence analysis) of the peak heights showing the locations within the healthy (H) and sick (S) buildings.

Figure 2 is a two-dimensional plot (from the correspondence analysis) of the peak heights of all 33 chemicals that were present in at least one sample at each of the 17 locations plotted in Figure 1. The investigators had identified 15 of the chemicals as either "indoor" or "outdoor," on the basis of previous studies and published literature. These are also indicated in Figure 2.

The Healthy Building

Figure 1 shows outdoor air for the healthy building near the top (11H), supply locations next to and immediately below outdoor air (14H and 15H), and exhaust locations near the bottom (12H, 13H, 16H, and 17H). Note the large distance between supply air before (14H) and after the fan (15H). This suggests that air chemistry changes as it passes the fan, perhaps from lubricants used for the fan itself or emissions from electrical components such as wire insulation.

All 33 VOC showed increases at this point in the circulation system and generally at all subsequent stages in the air flow. This was revealed by comparing the distance of each location from the air intakes and the chemical concentrations in these locations. However, not all substances increased to the same degree.



Peak #	Chemical Name	Peak #	Chemical Name
C17	*n*-Hexane	C29	Benzene
C36*	*n*-Heptane	C50	Toluene
C59	*n*-Octane	C69	Ethylbenzene
C82	*n*-Nonane	C71*	*m*-Xylene
C110	*n*-Decane	C71*	*p*-Xylene
C140	*n*-Undecane	C78	*o*-Xylene
C170	*n*-Dodecane	C94	Propylbenzene
C190	*n*-Tridecane	C99	1,3,5-Trimethylbenzene
C51	3-Methylheptane	C107	C_3-Alkylbenzene
C72	3-Methyloctane	C108	{1-Methyletheny}Benzene
C26	1,1,1-Trichloroethane	C114	*a*-Methyl-benzene-acetal-dehyde
C36*	Trichloroethane		
C60	Tetrachloroethane	C89	*a*-Pinene
C35	1-Butanol	C101	B–Pinene
C58	1-Pentanol	C111	Δ^3–Carene
C33	Pentanal	C116	Limonene
C57	Hexanal	C136	Terpane
C15	2-Butanone		
C18	Ethylacetate		

**Peaks Nos C36 and C71 were identified as mixtures of chemicals*

Figure 2

The 10 "indoor" chemicals had large, statistically significant correlations indicating that their concentrations increase as air passes through the healthy building. Meanwhile, the five "outdoor" chemicals (light aromatic hydrocarbons) had correlations which were not statistically different from zero; this indicates that there was no addition or accumulation of outdoor chemicals in the indoor environment of the healthy building.

The Sick Building

Figure 1 shows the flow of air through the sick building with outdoor air near the top (7S), supply air below (1S and 2S), and exhaust air at the bottom (3S and 4S). As in the healthy building, indoor chemicals have large statistically significant increases as their distance increases from the supply air. But unlike the healthy building, outdoor chemicals also showed a statistically significant increase in concentration with increased distance from the air supply.

The researchers interpreted this increase in outdoor chemicals in the sick building as a potential indicator or characteristic of sick buildings or of different types of ventilation systems. In addition to high concentrations of indoor chemicals, outdoor chemicals are trapped within the building and their concentration is amplified. We think it is equally plausible that there were sources of the outdoor chemicals at the furthest distances from the supply air; these could have been from interior sources or from infiltration resulting from reduced indoor/outdoor pressure differentials far from the supply fans. Or, it is possible that outdoor air was backdrafting into the ventilation system's exhaust side.

Figure 2 shows a clear difference in the distribution of chemicals classified as either indoor or outdoor. The indoor chemicals appear in the lower portion of the diagram while the outdoor chemicals appear in the upper portion. The distribution of indoor and outdoor chemicals by peak heights shown in Figure 2 is consistent with the distribution by location shown in Figure 1 — outdoor supply locations near the top and exhaust air near the bottom. The researchers suggest that other chemicals could be classified this way, although they did not present any results to verify this.

Other Analyses

The researchers used discriminant analysis and principal component analysis to make finer grained groupings of chemicals, evaluate their differences in relation to location, and to study the tendency of groups or classes of chemicals to differentiate sick and healthy buildings.

We will not describe the details of that work here, but the findings supported and reinforced the correspondence analysis. And it was found that no single chemical class was capable of distinguishing sick from healthy buildings. Also, chemicals in the same class lacked common origins or circulation patterns.

Light Aromatic Hydrocarbons Might Trigger SBS

In the sick preschool, light aromatic hydrocarbons (HC) increased with distance from the air supply, but no such gradient was seen in the healthy building. The authors do not venture to guess whether the concentration gradient of light aromatic HC is a key to sick building syndrome or only symptomatic of other problems.

They do suggest that the light aromatic HC could trigger the syndrome by preventing people from adapting completely to their presence. The lack of sensory adaptation "could lead to a persistent awareness of these chemicals together with a heightened sensory awareness of other annoying factors (agents)." They add: "In a related vein, although the formaldehyde levels in the present study were extremely low, this chemical might interact detrimentally with one or several volatile organic compounds."

Commentary

The mathematical analyses do not show that sick building syndrome is caused by the differences in contaminant concentrations. Rather, they seem to show that there is a significant difference in the way the air handling systems are controlling (or not controlling) the contaminant concentrations in one building compared to the other. The change in concentrations within the sick building may be only an indicator of some other environmental differences in the building which elicit the complaints and symptoms characteristic of sick building syndrome.

We think the usefulness of applying sophisticated mathematical and statistical analysis to sampling results is clearly demonstrated by the study. We would like to see the technique extended to other nonchemical factors in a multifactorial sick building study. It provides researchers and investigators of sick building problems with a valuable tool for analyzing their data. In light of the failure of simpler methods and the clear results in the Swedish preschool study, we think the extra effort is worth considering

For More Information

Elliot Noma, Birgitta Berglund, Ulf Berglund, Ingegerd Johansson, and John C. Baird, 1988. "Joint representation of physical locations and volatile organic compounds in indoor air from a healthy and a sick building." ***Atmospheric Environment*** Vol. 22, No. 3., pp. 451-460.

To obtain correspondence analysis computer software:Elliot Noma has developed a PC-based software package (which can also be run on a mainframe) with documentation for the use of correspondence analysis. He can be contacted at Statistical Modelling Associates, 234 Lawrence Avenue, Highland Park, NJ 08904; (201)246-4876. He sells the software package for $500/copy. ♦

Formaldehyde Sealants Evaluated

Researchers at Ball State University in Indiana have tested various sealants for reducing formaldehyde emissions from particleboard subflooring. The tests showed that sealants could be effective in reducing formaldehyde emissions, both in the short run and after more than six months.

Treatment reduced emissions as much as 95% in one test, although most sealants tested did not perform that well. Several were less than 50% effective. And the sealant which produced the highest single reduction (Hyde-Chek) was not as effective in two other tests. Another sealant, Valspar formaldehyde sealant, was more consistently effective, from 78-86% reduction. The complete results are shown in Table 1.

The researchers did not evaluate the sealants on other formaldehyde-emitting products (such as paneling and plywood) or on other uses of particle board (such as for cabinets or furniture). However, in general the levels of reduction achieved in these tests are proba-bly a good indication of the general effectiveness of the sealants for formaldehyde-resin-bound composite wood products.

Note: It is important to remember to use adequate ventilation when applying materials like the sealants. Ventilation should be maintained well after the sealant is applied, until the strong odor has disappeared. If upon reclosing the house the strong odor returns, continue to maintain good ventilation.

	MEASUREMENT PERIOD AFTER TREATMENT				
	Immediate			Retest	
Coating	% HCHO reduction to baseline	% HCHO reduction total	Time after application (months)	% HCHO reduction to baseline	% HCHO reduction total
Polyurethane (1 coat = #1)	75	60	17	42	33
Polyurethane (1 coat = #2)	47	39	—		
Polyurethane (1 coat = #3)	30	24	—		
Polyurethane (2 coats)	47	39	15	67	55
Nitrocellulose (1 coat = #1)	58	47	16.5	67	58
Nitrocellulose (1 coat = #2)	53	49	—		
Nitrocellulose (2 coats)	67	62	11.5	87	79
Alkyd resin (1 coat)	67	55	—		
Hyde-Chek (1 coat = #1)	95	86	—		
Hyde-Chek (1 coat = #2)	67	56	15	100	83
Hyde-Chek (1 coat = #3)	63	45	—		
Valspar (1 coat = #1)	86	60	7.5	86	60
Valspar (1 coat = #2)	78	59	—		
Tri-Con AP-10 (1 coat)	8	6	—		

Table 1

For More Information

Thad Godish and Jerome Rouch, "Control of Residential Formaldehyde Levels by Source Treatment" in *Indoor Air '87, Proceedings of the 4th International Conference on Indoor Air Quality and Climate*, Vol. 3. Berlin, West Germany, 17-21 August, 1987. Berlin: Institute for Water, Soil and Air Hygiene, pp. 221-225.

Contact Thad Godish of Ball State University, Muncie, Indiana. ♦

Products & Services

E-PERM in EPA Proficiency Tests

We have previously described and praised the E-PERM for radon measurements (see *IAQU*, September 1988). Recently, Rad Elec Inc., which makes E-PERM, sent us a copy of its device's test results in Round 5 of the National Radon Measurement Proficiency (RMP) Program.

The results show that the E-PERM devices tested gave 7% and 19% high readings for 7.5 pCi/l exposure and 12% and 17% high for 18 pCi/l exposure. These results are consistent with earlier results from EPA in Las Vegas. The E-PERM was found to yield an average difference of 6.3% for short-term tests (one week) and 8.5% for long-term tests (one month) compared to EPA's measurements of the test chamber radon levels. For screening purposes these results are acceptable.

What is not known from these tests is what degree of variation might result from operator differences, but from what we know about E-PERM, we would expect those differences to be small.

Rad Elec is marketing kits for professionals with a variety of options. For information, contact Rad Elec, 5330 J Spectrum Drive, 270 Technology Park, Fredrick, MD 21701; (301)694-0013. ♦

Mateson Chemicals for IAQ Control

Several products designed to remedy or control indoor air quality problems or their sources have been developed by Mateson Chemical Corporation of Philadelphia. Mateson has produced a "guidance document" — a chart it calls "FEELers and SEEers." The chart includes dried swatches of six products and allows potential users to actually see, touch, and smell the products. It is available upon request from Mateson at the address listed below.

The six products represented are available for air conditioning, ventilating, restoration, or air quality control contractors. They are Dust-Set, Soot-Set, Lint-Set, Cover-Up, Cover-Al, and Radox.

Many of Mateson's jobs begin with remediation after fires or other significant damage to buildings. It specializes in smoke odor neutralizers.

FEELers & SEEers

Dust-Set is a water soluble resin; it dries clear and is odorless. In the presence of water it will reactivate up to a certain point. It is used in ducts after they are cleaned. Jean Mateson recommends small HEPA vacuums with soft fiber fittings to clean fiber-lined ducts. In metal ducts, cut holes and go about two feet each way with the vacuum wand. Dust-Set is a topical application to inhibit the "lipoid" compounds' combustibility.

Soot-Set and Lint-Set have fire inhibiting properties, especially Lint-Set. Lint-Set is recommended where you have grease or linters in the air stream.

Cover-Up and Cover-Al are in the realm of paints. They were originally developed for covering fibrous materials like asbestos and fiberglass and to cover charred and burned surfaces after a fire. According to Mateson, Cover-Up sucks the volatile organics out and lets them off-gas. Cover-Al is a clear version of Cover-Up. It is in demand for treatment of large mechanical rooms. This way color coding on pipes and equipment is not covered in the application.

When applying these products, Mateson suggests that you run the air system to dry them out, changing filters before and after application.

In SBS cases, according to Mateson, when you get into building equipment rooms, you see a lot of spilled fluids. In hospitals you see systems which have been scrubbed with disinfectants and the disinfectants are polluting the air. It has to be neutralized.

Mateson said that in an asbestos remediation case, to save money, ordinary paints can often be used. In the mechanical room, oily surfaces will not hold the paint, or the components of the paint may off-gas into the air. Cover-Up and Cover-Al can properly seal these materials, according to Mateson.

Fuel oil including reclaimed oil, which is loaded with metals such as mercury and cadmium, often spills inside buildings. When they clean it up, employees track it all over and it off-gasses. It is very difficult to clean up — it is tenacious. Sometimes it gets into foundations or other inaccessible places. Mateson uses a neutralization detergent to clean it up as well as possible, then he treats the ducts with Cover-Up and Cover-Al.

PCB spills and transformer fires: when PCBs burn, smoke condenses on surfaces and no matter how much you clean, you still find contaminants when you take wipe samples. You have to seal the surfaces so that when you wipe you get acceptable levels. Use clean-up detox chemicals and then use Cover-Up or Cover-Al.

Radox is an acrylic latex rubber. It is useful primarily on surfaces subject to vibration, movement, or bending. It goes on as a liquid and cures into an elastomeric vapor barrier, which controls moisture, radon gas, built up hydrocarbons from a spill, or emissions. Radox cures faster when it is exposed to air, drying to a non-tacky finish after a couple of weeks. It can be painted during the first couple of weeks, before it sets up, and can be a good primer until the surface interacts with pollutants in the air. (In basements it will react with sulfur dioxides.)

Material safety data sheets are available for all of the products, as are toxicological studies done on each of them.

For More Information

Mateson Chemical Corporation, 1025 Montgomery Avenue, Philadelphia, PA 19125; (215)423-3200 ♦

Information Sources

Guidance for IAQ Investigations

The National Institute of Occupational Safety and Health (NIOSH) has published a booklet to assist building owners and operators investigating possible indoor air quality problems. The 24-page booklet covers NIOSH experience with IAQ problems and their most common causes, a self-help approach to evaluating indoor air problems, and where the reader can go for assistance if the self-evaluation does not resolve the problem.

NIOSH investigates IAQ problems through its Hazard Evaluation Program upon request from employee groups, unions, management, and local, state and federal agencies. NIOSH is part of the Centers for Disease Control, which in turn are in the Department of Health and Human Services. NIOSH is interested in health-based issues, rather than labor-based issues, which are the concern of OSHA, a part of the Department of Labor.

The Investigation Process

The NIOSH booklet describes a multi-staged approach involving:

1) backgound assessment,

2) initial site visit, and

3) a follow-up site visit.

During the background assessment, historical information on the building is obtained and information on the design and construction of the building is reviewed. Information is also obtained on the chronology of the occupants' symptoms, the types of symptoms, and the time of their occurrence. The symptoms information is often obtained through the use of questionnaires.

During the initial site visit, a walk-through evaluation is used to obtain additional information on the building design, construction, and operation. A critical inspection of the ventilation system seeks obvious sources of chemical or biological contamination. Personal interviews help the investigators better characterize the building population, the symptoms, and the complaints. Personal interviews also help determine the magnitude and distribution of the problem within the building, and questionnaires are sometimes employed to more accurately determine these factors.

Also during the initial site visit, environmental monitoring is used to confirm or rule out possible problems and sources identified in the background assessment and the walk-through evaluation. NIOSH uses CO_2 detector tubes, psychrometers for temperature and humidity, and smoke tubes for air movement. On occasion the presence of specific chemicals or microbiological contaminants is tested where appropriate. NIOSH warns against reliance on standard industrial hygiene methods for testing since many contaminants are usually present at concentrations far below those known to cause health-related problems in industry.

The criteria used to evaluate the results are those contained in ASHRAE standards rather than in the occupational limits established by ACGIH, OSHA, and EPA. In addition to the guidelines contained in ASHRAE's ventilation standards, NIOSH also uses ASHRAE comfort guidelines as criteria for assessing the thermal performance of the occupied space.

A follow-up site visit is used if a problem identified during the initial visit requires further definition, or if no problem can be isolated and additional site assessment work is required. Subsequent site visits involve more extensive and specific environmental monitoring for chemical and microbiological contaminants.

Results

The booklet states that while some episodes may be multifactorial, you can classify evaluations by the "primary" type of problem found. Note that this does not mean the "primary" problem caused the complaints, or that by remedying it the complaints abated. NIOSH classified the primary problems as follows: ventilation (52%), contamination from inside the building (17%), contamination from outside the building (11%), microbiological contamination (5%), contamination from the building fabric (3%), and unknown (12%).

NIOSH reports that the 52% of its investigations involving inadequate ventilation were based on ASHRAE standards 62-1981, "Ventilation for Acceptable Indoor Air Quality," and 55-1981, "Thermal Environmental Conditions for Human Occupancy."

Some of the ventilation problems encountered were the following:

- not enough fresh outdoor air supply;
- poor air distribution and mixing causing stratification, draftiness, and pressure differences between office spaces;
- temperature and humidity extremes or fluctuations;
- poor air filtration caused by improper or inadequate maintenance of filtration systems.

In many cases ventilation problems were caused or exacerbated by energy conservation measures, including reduced outside air supply; reduced infiltration; lower thermostat settings or economizer cycles in winter and elevated settings in summer; elimination of humidification or dehumidification systems; and early end-of-day shutdowns and late morning start-up of the ventilation system.

The 17% of the investigations identified as contamination generated inside included copying machines as the most significant source.

Emissions found from office copiers include methyl alcohol from spirit duplicators; butyl methacrylate from signature machines; and ammonia and acetic acid from blueprint copiers. Other inside contamination problems encountered by NIOSH include pesticide exposure from improper applications; dermatitis caused by boiler additives such as diethyl ethanolamine; improperly diluted cleaning products such as rug shampoo; tobacco smoke of all types; combustion gases from cafeteria or laboratory sources; and cross-contamination from poorly ventilated sources leaking into other air handling zones.

It is important to point out that these inside contaminants were primarily chemical in nature and that NIOSH measured them at levels far below occupational evaluation criteria, although above outdoor or normal ambient levels.

Outside contamination sources found in 11% of the investigations include motor vehicle exhaust, boiler gases, and previously exhausted air re-entrained into ventilation systems.

The re-entrainment problem was attributed to poorly located exhaust and intake devices or periodic wind changes. Other outdoor sources include construction or renovation project emissions such as asphalt, solvents, and dust. A common source of outside contamination is vehicle exhaust emitted from parking garages.

Five percent of the investigations involved microbiological contamination, and while not a common problem, it is considered a serious one because of the potential severity of its effects. Hypersensitivity pneumonitis is a severe respiratory problem which can be caused by bacteria, fungi, protozoa, and microbial products originating in ventilation systems. A similar illness, humidifier fever, also results from microbial contamination of ventilation system components.

The most common source of microbial problems identified in the NIOSH investigations was from water-damaged carpets or furnishings, or from standing water in HVAC system components.

Even where microbial contamination cannot be demonstrated as a cause of complaints, it is a problem which must be addressed when found due to potentially severe consequences.

Building fabric contamination identified in 3% of NIOSH's investigations often comes from building materials and products including insulations and composite wood products emitting formaldehyde; fibrous glass eroded from duct linings; and acetic acid from insufficiently cured silicone caulking.

Self Evaluation of Indoor Air Problems

The NIOSH booklet gives detailed questions to guide each of the investigation phases described above. While not an all-encompassing guide, it does cover many of the major issues which arise. It certainly is detailed enough to suit the purpose of assisting in a self assessment. However, the document goes a bit further and might lead to the conclusion that experienced professional assistance is not necessary. In fact, the guide is intended to allow identification of reasonably common problems and serves as a preliminary audit. In many instances, its use is likely to lead to many identifiable problems and potential remedies.

The booklet also contains a questionnaire which can be self administered to building occupants. The problem is that interpretation of the results does require a knowledgeable and experienced individual or team of experts. Some caution is warranted in not expecting to resolve all indoor air quality problems by following the guidance document. On the other hand, the booklet is not intended or expected to be useful in resolving all problems. And it would serve a building owner or operator to be familiar with the booklet before engaging professional consultants or calling NIOSH.

To Obtain a Copy

Guidance for Indoor Air Quality Investigations is available from Hazard Evaluations and Technical Assistance Branch, DSHEFS, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226; (513)841-4374. ♦

Environmental Quality in Offices

Last month we wrote about a number of studies on environmental factors other than air quality which can affect occupant satisfaction, health, and productivity. If you were interested in those articles, here is a book you will want to read. It is billed on the jacket as an "important new guide to office enhancement [which] can significantly boost worker satisfaction and productivity."

Environmental Quality in Offices, published last October by Van Nostrand Reinhold, is a comprehensive review of office building environmental quality issues and how to evaluate or assess them. It does not provide much depth on air quality issues, but we think the book will be of great value in broadening understanding of the full range of environmental considerations in office buildings.

Written by Jacqueline C. Vischer, an experienced consultant, teacher, and lecturer on building diagnostics and evaluation, the book reflects a bias we share with the author toward involvement of building users. They are seen as an important source of information about their office environment, and they are also seen as potentially important in making design decisions or operational decisions.

But Vischer also approaches buildings as dynamic and complex systems requiring sophisticated diagnostic tools and professionals to use them. She draws upon her experience working for Public

Works Canada, and she shares some of that experience by way of example in the book. We found these examples more useful than some of the general discussions.

Vischer highlights seven "building-in-use dimensions of office environmental quality" in a section describing sample question formats for survey questionnaires. These seven dimensions are thermal comfort, privacy, noise control, spatial comfort, lighting, building noise, and air quality. Interestingly, air quality and privacy were identified as problems in all three case study buildings presented. A distinction is made between what is expected and what is normal. Low scores were expected for air quality and privacy, but Vischer asserts that this does not make them acceptable.

She concludes that while occupants experience air quality and thermal comfort as "two of the most clear-cut dimensions of building-in-use performance," spatial comfort and privacy were better predictors of satisfaction and workability.

The text belies the jacket by giving enough information to show what is important (and that is valuable) but not enough detailed instruction for it to be applied directly by the reader. We think the book is excellent backgound reading or an introduction for those responsible for designing, managing, or operating office buildings. (We wish many of our clients would read it!)

Environmental Quality in Offices convincingly argues that to improve offices, we first have to measure them. Once we know what they are (in environmental terms) we can set about the task of improving them. If you do not think your office needs improvement, you might not need this book. We think it would be extremely useful for anyone wanting to improve their offices or the buildings they design or operate. It is very helpful if you are hiring consultants to perform building diagnostics or other types of office building evaluations.

Jacqueline C. Vischer, ***Environmental Quality in Offices***. New York: Van Nostrand Reinhold, 1988. 250 pages, $32.95. ♦

Asbestos Removal Reference Directory

Rimbach Publishing Inc. has announced the pre-publication solicitation for listings in its Asbestos Removal Reference Directory scheduled for release in May 1989. If you are in the asbestos removal business, your company can be listed at no charge in the following categories:

- AHERA planning
- Assessment
- Site removal
- Sampling
- Removal
- Disposal
- Encapsulation
- Reinsulation
- Personnel monitoring
- Specification preparation
- Sample preparation

To be included, send a 150-200 word summary of the services you provide. Include states where you hold licenses and insurance and bonding for each service area. Send any company brochures with the above information by March 15, 1989, to Asbestos Removal Reference Directory, Rimbach Publishing Inc., 8650 Babcock Blvd., Pittsburgh, PA 15237 ♦

Information Exchange

Again, *IAQU* extends an invitation to our readers to submit comments and questions to our editorial office in Santa Cruz, California. We wish to make our pages a forum for an exchange of ideas from the diverse group of interests you all represent. We are particularly interested in your suggestions for IAQ measurement and control: methods, hardware, information sources, etc. New products are important, and evaluative information on products, whether new or not, is of interest. ♦

From Our Readers

Chris Muller, manager of technology at Purafil, has written that he was "somewhat dismayed that *IAQU*, along with many others, appears to relegate gaseous contaminants to a lower priority than particulates where IAQ is concerned." His letter, too long to publish here, suggested that potassium permanganate-impregnated media (PURAFIL II) and enhanced capacity synthetic carbon media (PURACARB) filters offered by Purafil protect personnel and equipment from gaseous airborne contaminants. His letter was accompanied by a large set of case studies describing operating economies achieved in varied building types throughout the country. They also described numerous successes in removing odors or other contaminants in difficult situations like athletic facilities, sewage plants, urban schools, hospitals, cafeterias, and others.

Purafil filter media performance data from controlled experiments were not with the materials we received, so we called Muller and asked that he send them to us. We will share the information with our readers as soon as it is available.

For more information: Chris Muller, Manager of Technology, Purafil, P. O. Box 1188, Norcross, GA 30091; (800)222-6367. ♦

Calendar

February 3-4, **Symposium on Architecture and Building Construction Issues, with Consideration of Regional Climatic Conditions,** Baton Rouge, Louisiana. Contact: Dr. Jason Shih, School of Architecture, Louisiana State University, Baton Rouge, LA 70803

February 13-18, **Housing for Cold Climate, Third Annual Congress and Exhibition,** Minnesota Energy Council, St. Paul, Minnesota. Contact: Minnesota Energy Council, Box 76070, St. Paul, MN 55175

February 27-28, **Better Buildings Conference: Residential Energy Efficiency and Indoor Air Quality,** Albany, New York, Contact: Jim Lafferty, New York State Energy Office, 2 Rockefeller Plaza, Albany, NY 12202; (518)473-7243

April 17-20, **IAQ 89: The Human Equation: Health and Comfort,** San Diego, California. Contact: Jim Norman, ASHRAE, 1791 Tullie Circle, N.E., Atlanta, GA 30329; (404)636-8400

May 2-5, 1989, **EPA/APCA International Symposium on Measurement of Toxic and Related Air Pollutants,** Quality Inn, Mission Valley, Raleigh, NC. Contact: Seymour Hocheiser, Environmental Monitoring Systems Laboratory, U. S. Environmental Protection Agency, Research Triangle Park, NC 27711

June 20-24, **ASHRAE Annual Meeting,** Vancouver, British Columbia. Contact: Jim Norman, ASHRAE, 1791 Tullie Circle, N.E., Atlanta, GA 30329; (404)636-8400

July 16-19, **Symposium on Biological Contaminants in Indoor Environments, ASTM Subcommittee D22.05 on Indoor Air,** Boulder, CO. Contact: George Luciw, Staff Manager, Subcommittee D22.05 on Indoor Air, ASTM, 1916 Race Street, Philadelphia, PA 19103; (215)299-5400

October 11-13, **Blueprint for a Healthy House Conference,** Cleveland, OH. Contact: Housing Resource Center, 1820 W. 49 St., Cleveland, OH 44102; (216)281-4663

INTERNATIONAL

February 14-16, **"Present and Future of Indoor Air Quality,"** Sponsored by the Belgian Ministry of Public Health, The World Health Organization, and the Belgian Ministry of Hygiene and Epidemiology. Brussels, Belgium, Contact: D. Shanni - E.C.C.O.sprl, Rue Vilain XIIII, 17 AB-1050 Brussels, Belgium

June 19-22, **11th International Congress on Quality for Building Users, Council for Building Research, Studies and Documentation (CIB),** Paris, France. Contact: Jean-Louis Feliz, Centre Scientifique et Technique du Batiment, Relations Exteriereurs, 4 avenue du Recteur-Poincare 75782 Paris Cedex 16 France; Phone (1) 45 24 43 02

June 23-24, **"Building Simulation '89: Technology Improving the Energy Use, Comfort, and Economics of Buildings Worldwide,"** International Building Performance Simulation Association Vancouver, British Columbia, Canada. Contact: Dr. Marianne McCarthy Scott, MCC Systems Canada Inc., 30 Wellington Street East, #202 Toronto, ON, Canada M5E 1S3; (416)368-2959

September 1, **CLIMA 2000, the Second World Congress** Sarajevo, Yugoslavia. Contact: CLIMA 2000, Massinski Fakultet, Prof. Dr. Emin Kulic, 71000 Sarajevo, Omladinsko Setaliste bb, Yugoslavia.

October 16-20, **The Sick Building Syndrome Nordic Institute of Advanced Occupational Environment Studies (NIVA),** Copenhagen, Schafergarden. Contact: NIVA c/o Institute of Occupational Health Topeliuksenkatu 41 a ASF-00250 Helsinki, Finland; Phone: +358-0-47471

July 29 - August 3, 1990, **5th International Conference on Indoor Air Quality and Climate,** Toronto, Canada Contact: Dr. Douglas S. Walkinshaw Centre for Indoor Air Quality Research University of Toronto, 223 College Street, Toronto, Ontario, Canada M5T 1R4

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