Indoor Air Quality Update™

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

Vol. 1, No. 1 HAL LEVIN, EDITOR September 1988

In This Issue

VOC in Indoor Air

Many volatile organic compounds (VOC) are given off by building materials, furnishings, consumer products, office equipment, and supplies. And many of these compounds have known or potential health and physiological effects which might explain sick building syndrome. Sensationalized news reports of sick buildings imply that our living and work environments are a carcinogenic soup. *Are VOC the cause of sick building syndrome?* There are no definitive answers to this question, but despite our uncertainty the practicing field professional is being called upon to address the issue and "fix" the problem — if there really is one.

The substantial gaps in our knowledge about these pollutants are a source of frustration for indoor air quality professionals. Fortunately, recent research is providing useful information to help us deal with this problem. By integrating results from chamber emissions studies, sick building studies, and other experiments, *we are beginning to get a clearer idea of how to deal with VOC in the indoor environment.* The final answers will probably not be black-and-white. Sick building syndrome, for example, is probably caused in part by VOC, but most likely results from a combination of factors — other air pollutants and even nonchemical factors such as lighting, social interaction, biological aerosols, etc.

Why do sick buildings cause nose and throat complaints?

Study after study is showing the presence of a multitude of VOC in buildings. Researchers like Lance Wallace of the EPA have detected upwards of 300 compounds in a single building, and have identified a total of over 900 separate compounds in indoor air.

Lars Mølhave of Denmark recently reviewed 62 frequently found chemicals emitted from building materials and determined that *84% were known or suspected mucus*

Table 1
Health Effects of 62 Organic Chemicals Emitted from 42 Building Materials

Effect	Mucus Membrane or Eye Irritants	Carcinogens
Known	48%	—
Suspected	36%	28%
Unknown	1%	72%
None	15%	—

Table 2
Total Mean Concentrations of Volatile Organic Compounds, μg/m^3

Building Air			Chamber Air		
Outdoor	Supply	Room	Day 1	Day 41	Background
30	66	106	94	25	1.5

membrane irritants. (See Table 1.) This might explain why there is such a high complaint rate regarding irritation of the nose and throat in sick building syndrome. *28% of Mølhave's 62 compounds have been identified as suspected carcinogens.* So even when irritation and illness complaints subside, there is still reason for substantial concern about the levels of VOC in indoor air.

Building materials may act as a sponge for VOC

Building materials appear to adsorb VOC on their surfaces from other sources and then re-emit those compounds into building air, according to a recent study of a Swedish preschool. The materials then act as "secondary" or "indirect" sources of those air contaminants. This has practical implications — described on the next page — for protecting indoor air quality during the installation of furnishings or the application of finishes in buildings.

How the experiment was conducted

Ingegerd Johansson and her coworkers placed floor, wall, and ceiling materials removed from a seven-year-old preschool in a 1.9 cubic meter (67 ft^3) stainless steel chamber at 22°C (71.6°F) and 0.5 air changes per hour (ACH) for 41 days. The material surface area to chamber volume ratio mimicked that of the classroom (2.2 m^2/m^3). Clean air was passed through the chamber and exhaust air was analyzed for organic chemicals. Simultaneous measurements were made of the air entering and leaving the classroom through the HVAC system.

Emissions from the building materials initially raised the chamber VOC air concentration to 94 μg/m^3. This was only slightly lower than the VOC concentration in the classroom air which, at the start of the study, contained 106 μg/m^3. Table 2 lists VOC concentrations for outdoor air, classroom air, and air in the test chamber.

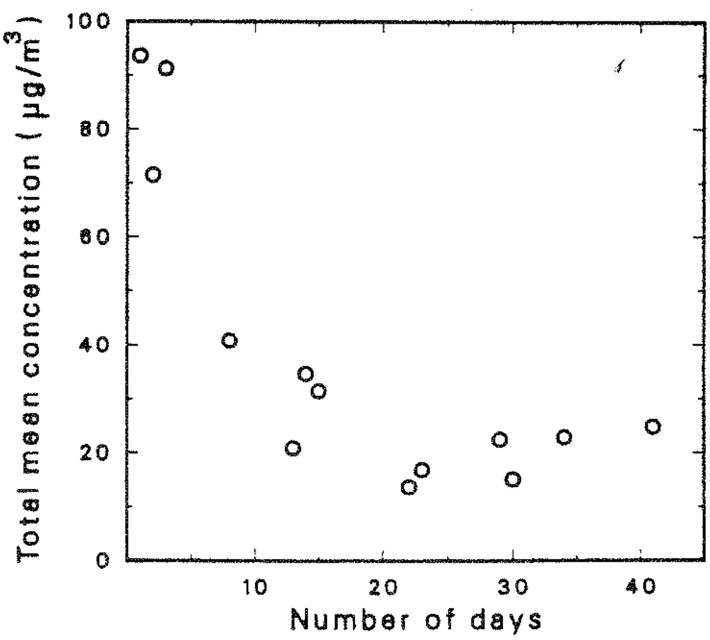
Figure 1 shows that the concentration of VOC in the chamber declined for about 30 days, then reached a steady state of about 25μg/m^3. The research team believes that this level resulted from VOC emitted by the tested materials themselves, rather than from secondary emission of adsorbed VOC.

What are the implications of this study?

The experiment demonstrated the "sponge" effect of the distribution of VOC in enclosed spaces. We can draw several practical conclusions from the results:

- *Much of the initially released VOC will be adsorbed onto other material surfaces* from new furnishings or finishes in spaces containing high-surface-area

Figure 1



Indoor Air Quality Update™

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

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According to the U.S. EPA, 20 to 35% of workers are in buildings with air quality problems causing illness, absenteeism, and low productivity.

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Indoor Air Quality Update

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materials such as carpeting, ceiling tiles, or free-standing partitions.

- *The quantities adsorbed will depend on the total surface area exposed as well as the air exchange rate* in the space. The rougher surfaces of insulation materials, textiles, and carpets will adsorb large quantities of VOC. The available surface area for adsorption on such "fleecy" materials is many times the plane surface measurement.
- *The lower the ventilation rate, the more VOC will be adsorbed on interior surfaces.* When ventilation is reduced or turned off (at night and on weekends, or during periods of warm or cold outdoor temperature), indoor air VOC concentrations will tend toward equilibrium; that is, they will rise until there is a balance between emissions from sources and removal from the air by ventilation, chemical reaction, or surface adsorption. As VOC are emitted from materials, they will be adsorbed on surfaces.
- *The higher the temperature, the higher the emissions and VOC air concentrations.*

Table 3
Organic Compounds Identified via GC/MS

Material/Product	Major Organic Compounds Identified
Latex Caulk	Methyl ethyl ketone, butyl propionate, 2-butoxyethanol, butanol, benzene, toluene
Floor Adhesive (water based)	Nonane, decane, undecane, dimethyloctane, 2-methylnonane, dimethylbenzene
Particleboard	Formaldehyde, acetone, hexanal, propanol, butanone, benzaldehyde, benzene
Moth Crystals	Para-dichlorobenzene
Floor Wax	Nonane, decane, undecane, dimethyloctane, trimethylcyclohexane, ethylmethylbenzene
Wood Stain	Nonane, decane, undecane, methyloctane, dimethylnonane, trimethylbenzene
Latex Paint	2-Propanol, butanone, ethylbenzene, propylbenzene, 1,1'-oxybisbutane, butyl propionate, toluene
Furniture Polish	Trimethylpentane, dimethylhexane, trimethylhexane, trimethylheptane, ethylbenzene, limonene
Polyurethane Floor Finish	Nonane, decane, undecane, butanone, ethylbenzene, dimethylbenzene
Room Freshener	Nonane, decane, undecane, ethylheptane, limonene, substituted aromatics (fragrances)

Practical recommendations

Based on our experience, you can take these steps to reduce the impact of the sponge effect in buildings with new furnishings or finishes.

1. ***Use maximum outside air ventilation*** during and following the installation of finishes and furnishings to reduce air levels of VOC emitted from new products and materials. *Use temporary exhaust* (through doors, operable windows, stair towers, and emergency exits) for exhausting air rather than the HVAC return system wherever possible. It is important to operate ventilation systems 24 hours per day, seven days per week during periods of elevated VOC.

2. ***Protect installed materials*** (with vapor barriers — i.e., sealed plastic coverings) to the extent feasible, during use of VOC-containing finishing products such as adhesives and paints and during installation of VOC-emitting furnishings and partitions.

3. ***Protect fiber-lined HVAC ducts and return air plenums*** from air flows to avoid contamination of system components. Exposed upper surfaces of ceiling panels and spray-on insulation enclosing concealed spaces used as return air plenums may adsorb large quantities of VOC if contaminated air circulates through them.

4. ***Operate newly occupied building areas at the lowest temperatures acceptable to occupants.*** Temperature excursions can cause bursts of VOC with low boiling points and cause episodic elevation of VOC levels.

For More Information

Berglund, B. I. Johansson, and T. Lindvall 1987. "Volatile Organic Compounds from Building Materials in a Simulated Chamber Study," *Indoor Air '87; Proceedings of The 4th International Con-*

Table 4
Moth Crystal Emission Factors, Para-dichlorobenzene (µg/cm²-hr)

Air Exchange Rate (air changes per hour)	Temperature = 23°C	Temperature = 35°C
0.25	1250	4600
0.5	1400	4850
1.0	1750	5700
2.0	2000	6700

ference on Indoor Air Quality and Climate, Vol. 1. Berlin: Institute for Water, Soil and Air Hygiene. pp. 16-21.

Measurements of emissions from interior furnishings

Recent chamber tests of VOC emissions from various building materials, furnishings, and consumer products are producing important data for the control of VOC in indoor air. The purpose of the tests, performed by Bruce Tichenor at EPA's Air and Engineering Research Laboratory in Research Triangle Park, NC, was to identify and quantify emissions from a variety of sources of indoor air contaminants, and to measure the effect of various factors on emission rates. These factors include temperature, relative humidity, air exchange rate, and chamber loading.

Tichenor screened materials using headspace testing and gas chromatography/mass spectrometry (GC/MS) analysis to identify the materials' emissions. Tests used a small chamber (166 liter) with carefully controlled temperature, relative humidity, and airflow. The materials were placed in the chamber shortly after application to the test surface and the first sample was collected 30 minutes after the chamber door was closed. Samples were collected on a tenax-charcoal combination, thermally desorbed,

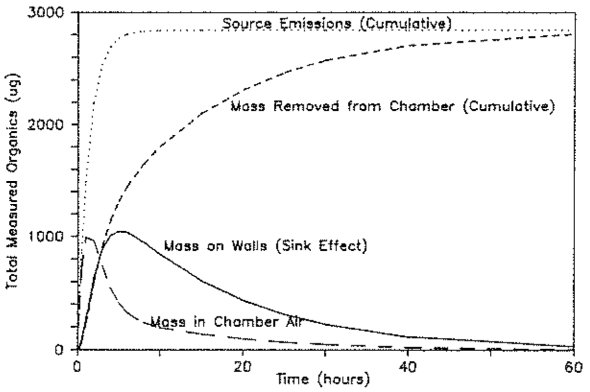

Figure 2— Chamber "Sink Effect"—Caulking Compound
T = 23°C; RH = 50%; ACH = 0.36

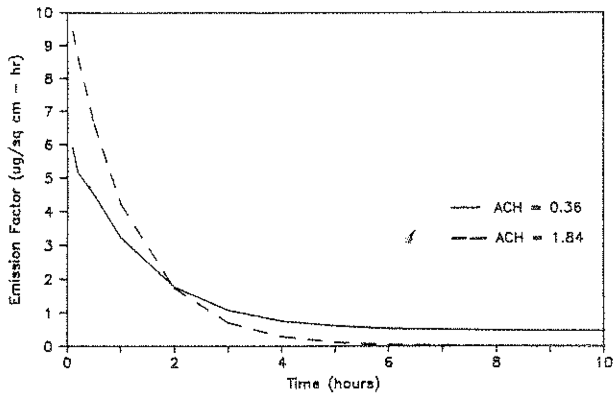

Figure 3 — Emission Factor vs. Time — Caulking Compound
Total Measured Organics

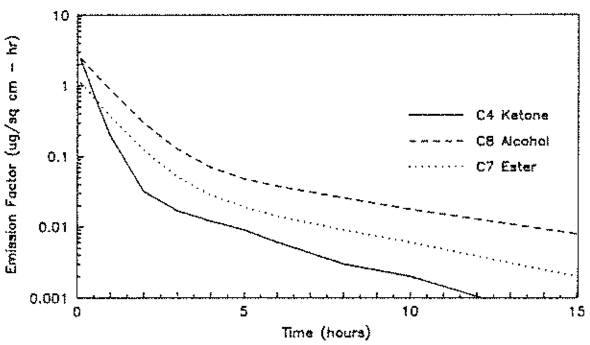

Figure 4 — Caulk Emissions vs. Time — Three Compounds
T = 23°C; RH = 50%; ACH = 0.36

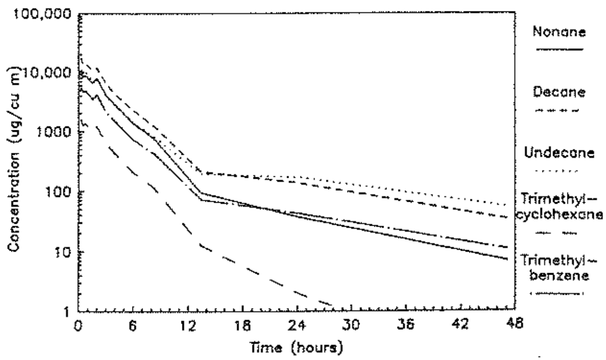

Figure 5 — Concentration vs. Time — Floor Wax
T = 22°C; RH = 50%; ACH = 0.5

and about 10 compounds were analyzed by gas chromatography/ flame ionization detection (GC/FID).

Tichenor evaluated several types of materials, including silicone caulk, floor adhesive, floor wax, wood stain, moth crystal cakes, and particleboard.

Table 3 lists organic compounds identified by the chamber tests. Several of the compounds on the list affect the central nervous system, some are known irritants, and several are known or suspected animal carcinogens or teratogens (substances that cause birth defects).

In Table 4, we see the effects of air exchange rate and temperature on the emission of moth crystal cakes. The effect of temperature is quite large, and the effect of air exchange rate is significant also. The air exchange rates used represent the range of rates found in residences and in public buildings such as offices or schools. The effect of temperature on emissions from moth crystals would be similar to the effect on other VOC sources.

The effect of time on the emission rates is shown in Figures 2 - 5.

Tichenor found significant sponge or "sink" effects in the chamber. Figure 2 illustrates the sink effect, showing the mass of organics from the caulking compound adsorbed on chamber walls (even though the chamber was stainless steel). Even though the emissions occur rapidly, the sink effect (or sponge effect) significantly lengthens the time until emissions are removed from chamber air.

Practical implications

Tichenor's work demonstrates that emission rates for "wet" materials can decrease rather sharply during the first few hours after application. However, a *critical factor in the rate of decrease is the ventilation rate.*

For the caulking compound tested, emissions were close to zero after six hours at 1.84 ACH while at 0.36 ACH, significant emissions were still observed at 10 hours and the emission rate was declining very slowly (see Figure 3). Emission rates were reasonably similar for three compounds, C4 ketone, C8 alcohol, and C7 ester (see Figure 4). This shows that *maximum available ventilation should be used during and immediately after the application of these materials.*

Concentrations of many of the compounds emitted from floor wax at 0.5 ACH — which decreased sharply during the first 12 hours from 10^3-10^4 $\mu g/m^3$ to 10^2 $\mu g/m^3$ — were still at 10^1 $\mu g/m^3$ and decreasing at 48 hours, when the experiment ended (see Figure 5).

Floors waxed on a Friday afternoon will still be emitting significant quantities of several compounds on Monday morning and beyond, even with ventilation rates greater than normally found during weekends in unoccupied (no mechanical ventilation operating) schools and office buildings.

We recommend that floor waxing be scheduled before weekends or holidays, that maximum practical outside air ventilation be used during floor wax applications, and that ventilation be run continuously until the building is reoccupied.

For more information

Tichenor, B. 1987. "Organic Emission Measurements Via Small Chamber Testing." *Indoor Air '87; Proceedings of The 4th International Conference on Indoor Air Quality and Climate,* Vol. 1. Berlin: Institute for Water, Soil and Air Hygiene, pp. 8-15 or contact Bruce Tichenor at AEERL, U.S. EPA, Research Triangle Park, NC 27711. ♦

Practical Research Briefs

Sealants Ineffective for PCP Control in Log Homes

Tens of thousands of Americans live in log homes. Many of the homes are built from logs treated with the wood preservative pentachlorophenol (PCP). Millions of other Americans live in homes where PCP has been used to preserve wood used in the foundation, structure, or interior.

Due to the toxicity of PCP, the EPA has restricted its use to reduce human exposure. Two years ago the EPA completed a regulatory action eliminating consumer access to PCP-containing products and banning PCP application to wood used indoors except sash and millwork partially exposed to the exterior. In those limited cases, PCP-treated wood must be sealed on the interior.

The EPA recently released a report on PCP-treated log homes suggesting that *sealing treated wood has little effect on PCP levels in indoor air.*

The hazards of PCP

PCP's toxicity is attributed to the common contaminants of the commercial formulations: dioxins, furans, and hexachlorobenzene. Commercial PCP is a teratogen in laboratory animals and a possible animal carcinogen. (A recently completed National Toxicology Program [NTP] study of commercial grade PCP found clear evidence of carcinogenicity in laboratory mice.) It also causes immune system damage in experimental animals.

Because PCP has relatively low vapor pressure, it tends to be emitted very slowly from materials that have been treated with it. There is evidence that *PCP can still be found in building air 15 to 20 years after initial application,* maybe even longer.

Several studies have compared PCP air levels in log homes to those in non-PCP-treated log homes. They have all found elevated air levels in the PCP-treated homes and elevated body burdens (blood levels and urinary levels) in the occupants, *with the highest levels in children.*

According to the EPA report, there were *no significant differences between PCP air levels in PCP-treated log homes with and without sealants applied to the treated surfaces.* This contradicts earlier published reports which suggested that polyurethane varnish or other sealants could be effective in reducing indoor air levels of PCP.

Although the recent study does not support the usefulness of sealant systems, EPA has not issued any guidance about alternatives for occupants of buildings containing PCP-treated wood.

Advice for homeowners and occupants

- *Check to see if PCP is present.* If you believe your home might be contaminated by PCP, obtain all available information from the builder, previous owner, or termite control company that may have used the chemical. If you suspect contamination, seek advice from local or state health officials on obtaining the services of a qualified professional to collect samples and submit them to a laboratory.

  The easiest and most economical samples to collect are from potentially treated wood or soil. If the samples are positive, air samples should be collected and analyzed, again by a qualified professional. Conditions in the building should be similar to typical occupancy conditions prior to and during the sample collection.

- If you notice unusual health in any occupants, particularly children, *seek medical attention immediately.* Inform the physician that you suspect exposure to PCP is a possible causal factor.

- *Reduce PCP air levels.* The quickest way to reduce the levels of PCP in the air is to increase outside air ventilation. From our experience, ventilation could reduce air levels of PCP by at least half and possibly even more, particularly in poorly ventilated buildings.

- *Isolate the source of PCP* as much as possible from the air circulating in the occupied portion of the house. This is why sealing treated wood has been tried in the past. But only dip-treated or brush-applied PCP-treated wood is amenable to some form of chemical isolation, not pressure-treated wood.

  A product called Permatox Pentite, manufactured by Chapman Chemical of Memphis, TN, chemically interacts with PCP to neutalize it. We have no recent information on its effectiveness, short- or long-term.

- *Remove and replace PCP pressure-treated wood* if possible. If this is not feasible, a substantial reduction may be achieved by completely encasing PCP-treated wood with drywall, plaster, or another air-tight wall covering material. A vapor barrier (such as polyethylene sheeting) can be used under the wall covering to increase the barrier. This should increase the resistance to PCP entry into the building, forcing the emitted PCP to escape through the exterior of the wall or roof.

For more information

"Pentachlorophenol in Log Homes: A Study of Environmental and Clinical Aspects" EPA-560/5-87-001, December 1986.

Report #349, National Toxicology Program, Research Triangle Park, NC 27711; (919)541-3991.

World Health Organization, *Pentachlorophenol, Environmental Health Criteria 71.* Geneva: World Health Organization. Available from WHO Publications Centre USA, 49 Sheridan Avenue, Albany, NY 12210. 236 pages. ♦

Room-size Air Cleaners: Do They Work?

While most air cleaners are purchased for particle removal, especially tobacco smoke and pollen, odor control is also a reason for air cleaner purchase. Some air cleaner manufacturers are now claiming their products are effective in removing VOC and nitrogen dioxide.

Joan Daisey and Al Hodgson of U.C. Berkeley's Lawrence Berkeley Laboratory (LBL) reported results of their air cleaner tests at the Air Pollution Control Association Annual Meeting in Dallas last June.

They tested one of each of the four different types of portable, "room size" air cleaners for removal of nitrogen dioxide (NO_2) and six representative volatile organic compounds (VOC). All of the devices tested used at least some activated charcoal along with other cleaning methods. The results were less than encouraging.

A previous report by a group of LBL researchers reported tobacco smoke removal rates for eleven portable air cleaners. A wide range of performance characteristics were found among the four basic types of devices: panel filters (PF), extended surface filters (ESF), electrostatic precipitators (EP), and negative ion generators (IG).

What they found

Daisey and Hodgson found that initial performance (when new) for two of the air cleaners was "reasonably effective" in removing NO_2 and five of the six VOC. These devices (the PF and ESF types) had relatively high flow rates and larger amounts of activated charcoal than the other, less effective devices. But after only 150 hours of operation in a residence (a small portion of the rated life), the most effective devices become substantially less effective.

The earlier LBL study found that electrostatic filters and extended surface filters had the greatest efficiencies, and the more popular panel filter had the poorest efficiencies. The negative ion generators had mixed performance, but even the better one was modest compared with the ESF and EP types. And the researchers indicated that since the more effective IG type had no integral collector surface, therefore making the walls and furniture the collection surfaces, soiling of these surfaces may ultimately be a problem. But the investigators concluded that even with the most effective of the devices tested, a strong odor of tobacco smoke remained.

Implications

- Portable commercial air cleaners may remove specific substances, but there is reason to read manufacturers' claims about performance and effective life of filter media with caution, even skepticism.
- Higher volumes of air processed are generally associated with more effective performance, although this criterion is independent of the effectiveness for removal of particular substances.
- Significant removal of tobacco smoke odor requires ventilation.

More information to come

We are currently reviewing the available literature on residential and room air cleaners, and we will report our findings in future issues of IAQU. If you have study results to share, please send them to us at our editorial office in Santa Cruz.

For more information

J. M. Daisey and A. T. Hodgson, "Air Cleaner Efficiencies for Removal of Nitrogen Dioxide and Volatile Organic Compounds."

and

F.J. Offerman et al, "Control of Respirable Particles in Indoor Air with Portable Air Cleaners." from: Lawrence Berkeley Laboratory, Building 90, Room 3058, University of California, Berkeley, CA 94720.♦

From the Field

Pontiac Fever Outbreak and Cooling Towers

Cooling towers can be the source of Legionella pneumophila, the naturally occurring bacteria that cause Legionnaire's Disease and that probably cause the building-related illness known as Pontiac Fever.

Pontiac Fever is a "self-limited illness characterized by headache, myalgia, and fatigue." (Myalgia is muscle pain.) Pontiac Fever is a non pneumonic, influenza-like illness which usually affects a high percentage of building occupants, has a short (36-hour) incubation period, and is transmitted in air from a heated water source. The similarity to flu might result in under-reporting of the number of incidents which have actually occurred.

An outbreak of Pontiac Fever in a New York City office building in April 1984 followed the pattern of previously reported outbreaks.

What happened in NYC?

In the New York City building, *the illness affected 83 percent of the office workers and 68 percent of visitors*. The median duration of the illness was four days, and symptoms were similar to many types of flu. The outbreak occurred in the spring, and therefore investigators hypothesized that increased cooling tower water temperature contributed to the growth of the organism. Most of the other documented outbreaks of Pontiac Fever have occurred in spring or summer.

In the NYC outbreak, investigators found the bacteria in a dedicated cooling tower and the outbreak clustered among people in the area served by that cooling tower. *The cooling tower exhaust was about 12 feet from the HVAC air intakes.*

Maintenance hyperchlorination was effective within 24 hours of application in preventing growth of the organism, although the long-term corrosive effect of chlorine on the cooling tower components may be a problem. Efforts to control legionella growth with quarternary ammonia compounds was not found to be effective as quickly, although the results were good eventually.

What can you do about Pontiac Fever?

Prevention:

- Locate building ventilation intakes as far as possible from supply air intakes, and not downwind under prevailing spring and summer conditions.
- Inspect and clean cooling towers and test and — if necessary — disinfect cooling water each spring, or whenever air conditioning is initiated after being shut down during cooler weather.

Remediation:

- Seek qualified medical diagnosis immediately if you suspect Pontiac fever.
- Pontiac Fever is most likely to occur in spring or summer. If flu-like symptoms are reported, you should consider medical surveillance and investigate possible cooling tower contamination.
- Disinfect cooling towers under the direction of public health or medical personnel. You may obtain advice from the Centers for Disease Control, United States Public Health Service, Atlanta, GA., or NIOSH (a sub-unit of CDC) in Morgantown, WV.

For more information

S. Friedman, K. Spitalny, J. Barbaree, Y. Faur, and R. McKinney. "Pontiac fever outbreak associated with a cooling tower," *American Journal of Public Health* (May 1987) Vol 77, No. 5, pp. 568-572. ♦

Chlorpyrifos — Pest Control with Caution

Chlorpyrifos is an organophosphate pesticide sold under the trade name "Dursban" by Dow Chemical. Widely used against fleas and cockroaches indoors, it *is suspected of being the causative agent in several sick building complaints.* In one case a receptionist working in an office when an exterminator sprayed chlorpyrifos developed *twitching, drooling, muscle spasms, confusion, and other symptoms.*

The Hazard Evaluation System Information Service (HESIS) in the California Department of Health Services reports that it has logged a dozen calls about possible chlorpyrifos poisoning and the department's Community Toxicology Unit has received many more. Sulfur compounds which volatize from chlorpyrifos have a strong, unpleasant odor and even at low exposure levels, the odor alone can cause headache and nausea. In most cases, reported complaints are limited to those symptoms, but according to HESIS even if only incidental skin contact with chlorpyrifos residues occurs, adsorption of sufficient quantities to cause cholinesterase inhibition is possible.

The Permissible Exposure Limit (PEL) for airborne chlorpyrifos is 0.2 $\mu g/m^3$. Application instructions require spraying only on cracks or floors rather than work surfaces, and only at times when employees are not present. We need to gather far more information on the health effects of chlorpyrifos.

For more information

California Department of Health Services; Hazard Evaluation System and Information Service (HESIS), 2151 Berkeley Way, Room 504, Berkeley CA 94704; (415)540-2115.

National Pesticides Telecommunications Network, (800)858-7378. A source of balanced information about the use and misuse of pesticides, health hazards, and other concerns. They request a contribution to cover copying costs for materials they send, but they do not charge for telephone consultation with knowledgeable individuals.

National Coalition Against the Misuse of Pesticides (NCAMP), 530 7th Street, S.E., Washington, DC 20003; (202)543-5450. A source of information and an advocacy group that has been active in chlordane regulatory and legal actions. ♦

Elevated Radon Reported in Commercial Buildings

Most current thinking on radon is that nonresidential buildings are not likely to have elevated levels. However, some recent research as well as common sense suggest that the first, second, or even third floors of nonresidential buildings may be at just as great a risk as similar locations in residential buildings.

Measurements made in Indiana by consultant Virgil Konopinski indicate that stores, offices, churches, and schools may have elevated levels. At the American Industrial Hygiene Conference in San Francisco last May, Konopinski reported finding radon levels as high as 23 picocuries per liter (pCi/l), well above EPA's guideline of 4 pCi/l. And the mean concentration for each building ranged from 2.3 pCi/l for schools to 3.5 pCi/l for offices and stores. 44.4% of the offices/

Table 5
Radon in Indiana Public and Commercial Structures

Building Type	Radon Levels		
	Mean pCi/l	Above 4pCi/l	Max pCi/l
Public Buildings	2.4	14.9%	23.0
Schools	2.3	13.0%	15.0
Offices/stores	3.5	44.4%	5.6
Churches	3.2	25.0%	5.3

stores and 25% of the churches exceeded 4 pCi/l, while only 14.9% of the public buildings and 13% of the schools were above 4 pCi/l. (See Table 5.)

While Konopinski's report raises concern about levels of radon in nonresidential spaces, it is important to note that his measurements were made continuously (24 hours/day, seven days/week) in buildings where ventilation is run intermittently. Furthermore, his measurements were not duplicated, were relatively short-term, and need to be followed up with longer sampling times in multiple locations within suspect structures. Nonetheless, it is clear that nonresidential buildings can have significant radon levels. In areas where elevated radon levels are known or believed to be common, radon measurement and possibly mitigation appear warranted.

What should building owners do?

- Check for radon in nonresidential buildings such as schools, stores, offices, and libraries located in geographical areas where elevated radon levels have been found in homes. If you are not sure about your area, consult your local or state environmental health office or the EPA regional office for your area.

Testing:

- Passive monitors are economical and can be used for short (days), medium (weeks), or long (months) test periods. Grab samples can be collected during ventilation system operation (normal occupancy conditions) and after ventilation system non-operation periods to assess the impact of ventilation on the results obtained with the passive monitors. Test locations should reflect the different types of spaces, relationship to the potential radon source and entry points, and variations in ventilation conditions throughout the building.
- If you get results indicating a possible problem, obtain the services of a qualified professional. Before you purchase devices to conduct your own testing, obtain some literature from EPA or your state or local health department and become familiar with the various types of tests, their use, and their limitations.

Mitigation:

- Unlike many other pollutants, the solution to radon contamination is not necessarily an increase in ventilation. In fact, increased ventilation can, in certain situations, actually increase radon levels indoors. Therefore, careful and thorough evaluation of radon levels, entry points, and the impacts of ventilation should be completed before selecting mitigation strategies.
- Mitigation essentially means reducing the entry of radon into the building. This is done by sealing routes of entry and by reducing or reversing the negative pressure differential between the building side and the source side of slabs or basement or foundation walls. This can be done by decreasing the pressure on the outside of the wall or increasing it on the inside. Details are contained in the publications described below.

New Construction:

- Mitigation measures are more economical when applied during construction. Therefore, try to determine the potential for sources of radon prior to foundation work. The Maryland school building described in the following article is an example of such a project.

For the IAQ professional

- Considering the above information, we believe that radon measurement will become increasingly common in low-rise nonresidential buildings in the coming months and years. Professionals should become familiar with measurement technology, methods, and protocols. The effect of HVAC operation on measurements should be carefully considered in planning measurements and in interpreting the results in nonresidential buildings.

For more information:
"Practical Radon Control " is a spe-

cial report on radon which contains valuable information on investigating buildings, testing, and selecting and installing mitigation measures. The report is available for $40 from Cutter Information Corp., 1100 Massachusetts Avenue, Arlington, MA 02174; (617)648-8700.

A list of companies providing radon measurement services is available from EPA or your state health department.

EPA has published a comprehensive report on radon control, "Radon Reduction Techniques for Detached Houses, Technical Guidance," 2nd Edition, EPA Report 625/5-87/019. It should be available at most EPA regional offices or from the EPA's Center for Environmental Research Information, Distribution, 26 W St. Clair Street, Cincinnati, OH 45268.

A brief overview of the above report is available in the booklet, "Radon Reduction Methods: A Homeowner's Guide (Second Edition)," OPA-87-010. ♦

Maryland School Employs Radon Reduction Measures in Construction

In Maryland, school officials have installed radon mitigation measures during the construction of a new Fairfax County elementary school. Many residences in the area have radon levels above the 4pCi/l action level recommended by EPA. While evaluation of the results are not yet available, the mitigation measures are noteworthy.

The 5,200 m^2 (48,310 sq ft) first floor of the school is a four-inch thick concrete slab, poured in areas of less than 790 sq ft with tongue-and-groove joints between pours. It is located on mixed soil types including sandy silt, clay, and rock fragments. Walls above and below grade are concrete block.

Subslab radon measurements collected thus far have been considerably lower (as much as ten times lower) than soil gas measurements taken before pouring the slab. It appears that the slab itself changes the radon emanation rate from the soil. However, there have been large variations in subslab radon measurements collected over a six-month period, and in relationships between these measurements and soil gas levels. These data reinforce concern about the variability of radon measurements and the need for long-term, integrated sample collection.

Radon reduction measures

The radon control features include the following:

- Placing at least four inches of clean, coarse aggregate under the slab and a plastic film barrier between the aggregate and the slab;
- Installation of a removable plastic strip (8 x 10 inches) at the expansion joint to allow for effective sealing of the floor/wall joint with flowable polyurethane caulking;
- The sealing or plugging of utility penetrations where possible;
- Painting of interior block walls;
- Design of HVAC to operate continuously in an overpressurization mode.

Should elevated levels of radon be found after construction is complete, ventilation of the void space under the slab will provide efficient and cost-effective mitigation. Operation of the HVAC in the over-pressurizing mode will inhibit radon entry into the occupied zone.

We will report the results of monitoring when the school is complete and occupied this coming fall.

For More Information

Kelly A. Witter, Air and Energy Engineering Research Laboratory, U.S. EPA, Research Triangle Park, NC 27711.

Or see the paper published in the proceedings of ASHRAE's *IAQ'88, Engineering Solutions to Indoor Air Problems,* available from ASHRAE, 1791 Tullie Circle, Atlanta, GA 30329. ♦

Tools & Techniques

Honeywell Offering IAQ Diagnostics Courses

Starting this summer Honeywell's Indoor Air Diagnostics Group will offer various 4 1/2-day training courses in building diagnostics for professionals. Passing the optional exam at the end of the course will qualify individuals to be authorized Honeywell IAQ Diagnosticians.

The course will emphasize four primary elements essential to the practice of building diagnostics:

1. Knowledge of what to measure;
2. Availability of appropriate instruments and other measurement tools;
3. Experience in interpreting and analyzing the measurements;
4. Using the interpretation for predicting the future performance of the building based on that interpretation.

Instructors will place additional emphasis on developing skills to recommend and implement changes in building environmental control strategies.

The course will be developed around modules that will allow the emphasis to vary from one offering to another. This flexibility will suit the varying requirements of students, who will come from several professions and disciplines. These include building systems engineers; architects; industrial hygienists; professionals in building management, safety and health; and professional commercial building energy auditors. Registered engineers and certified industrial hygienists who successfully complete the course will qualify for continuing education units or points from the American Board of Industrial Hygiene.

To get more information about the course, contact Honeywell IAQ Diagnostics, MN10-1451, 1985 Douglas Dr. North, Golden Valley, MN 55422-3992; (612)542-7043. ♦

On the Horizon

Computer Models for Analyzing and Predicting Air Quality

An exciting development underway in the indoor air quality field is the *development of computer models that would consider pollutant emission and removal rates in conjunction with specification of ventilation for indoor air quality.* The imminent development of these tools was described at the Indoor Air '87 conference in Berlin last August by Prof. Eystein Rodahl (Norwegian Institute of Technology, University of Trondheim, Norway) during his plenary lecture, "Ventilation Effectiveness — Past and Future."

Dr. Rodahl spoke of PC-based models which sounded *similar to models now available for energy conservation or illumination design.* These are graphically sophisticated, three-dimensional design tools with the potential to manipulate critical design variables and analyze the energy or lighting implications. Similar design tools for ventilation and indoor air quality are envisioned by Rodahl, which would give back the responsibility for ventilation design to the architect.

Current models under development

1. **Indoor Air Model.** Leslie E. Sparks, U.S. Environmental Protection Agency, Air and Energy Engineering Research Laboratory.

We received a review copy of Version 1.0, Feb 1988 Draft of the Indoor Air Model being developed by Sparks. It is a very simple model, a starting place, perhaps, for something yet to come. Its intended current application is the residential environment, although it could be applied to a simple non-residential building.

The current version of the model comes with emissions rates for only a few pollutants. Many more will be necessary to make the model truly practical, and the acquisition of the necessary data to accomplish that is not on the horizon. It handles mechanical ventilation systems by treating them as another compartment in the building.

The current version is intended as a developmental tool; eventually it might be developed into something useful for design. We will inform you as the model progresses.

For more information, contact Leslie Sparks, AEERL, EPA, Research Triangle Park, NC 27711.

2. **CONTAM86** James W. Axley, National Bureau of Standards.

With funding from EPA and DOE, NBS has developed a sophisticated indoor air quality model, CONTAM86, which is currently more useful for research than for practical use. However, Axley told IAQU that they may develop a more user-friendly version for health officials, consultants, and sophisticated design professionals. Like EPA's model described above, the current version of CONTAM86 is for residential buildings. It has been developed primarily as a research tool with strong emphasis on theory, but with an eye to expanding its capability to handle more complex building types.

Axley describes it as capable of modeling the complete HVAC system as well as the building. He claims the model is more complete than most (such as EPA's) in its modeling of complete building systems.

CONTAM86 draws on thermal flow models, developed earlier for building energy analysis, to model contaminant dispersal and ultimately define contaminant concentrations. The eventual purpose is to develop theory for IAQ including the following:

- airflow analysis,
- contaminant dispersal analysis,
- reverse contaminant dispersal (tracer gas decay) analysis, and
- building thermal performance (to come later).

Validation of the model against building measurements has begun and is encouraging, but future model development activities will improve performance by accounting for more factors and variables.

For more information: James W. Axley, *Indoor Air Quality Model-*

ing Phase I Report NBSIR 87-3661. Available from National Bureau of Standards, Center for Building Technology, Gaithersburg, MD 20899.

3. William W. Nazaroff and Glen Cass, California Institute of Technology.

Nazaroff and Cass of Cal Tech have developed and applied a mathematical model for predicting concentrations of chemically reactive compounds in indoor air. The model was used in connection with the design of a museum gallery and concentrations measured in the completed gallery were in close agreement with the model. The model has many applications including assessment of effects of filtration of selected compounds, design of ventilation scheduling for IAQ control, and simulation of unusual chemicals present in special situations.

For more information, see the published article in *ES&T* (Environmental Science and Technology), 1986, Vol. 20, pp. 924-934. ♦

News & Analysis

Mitchell IAQ Bill to Senate Floor

The major current indoor air legislation in Congress, S. 1629, sponsored by Senator George Mitchell, was approved July 14th by the Committee on Environment and Public Works and is awaiting consideration on the Senate floor. As of August 10 it was not scheduled to be heard by the full Senate, and our sources said there were no plans to bring it to the floor. The bill has been changed (most say "improved") considerably since its introduction.

Significant among the Senate bill's provisions are the authorization of $49.5 million total to be spent as follows:

- **Research:** $18 M to include $4.5 M each for IAQ control technology demonstration and for the preparation of health advisories. Funding also provided to conduct exposure assessment and particularly to assess exposure in schools resulting in a report to Congress. The health advisories would (at a minimum) specifically be required to analyze risk and identify relevant standards and no-effect levels (NOEL) for important indoor air pollutants.
- **National IAQ response plan:** $10 M to include at least $1 M for the federal building response and demonstration plan, and $2 M for a national IAQ clearing house. Additionally, an IAQ office would be established at EPA. 0.5% of the design and construction budget for new federal buildings would have to be devoted to IAQ control.
- **State and local programs:** $12 M to encourage and assist states and localities to develop and implement their own programs.
- **Building assessment demonstration program:** $5 M, mostly for NIOSH investigations and research on studies of problem buildings.
- **Regional radon training centers:** $2 M. Several throughout the country.
- **Council on IAQ:** $1.5 M. To be staffed by EPA.
- **Protocols to measure radon in child care facilities:** $1 M.

The bill would also require EPA to publish a nonregulatory list of indoor air contaminants, not subject to rulemaking procedures. And the new EPA headquarters building in Washington would be an IAQ demonstration building. The building is scheduled for initial occupancy in September 1992.

[Note: IAQU Editor Hal Levin has been retained as the lead IAQ consultant for the new EPA headquarters building, which is under predesign phase study by consultants to EPA's Facilities and Support Services Division.]

Meanwhile, Rep. Joseph Kennedy's companion to S. 1629 has not been heard in the House. Rep. Claudine Schneider is working on a bill based on the current version of Sen. Mitchell's, and her staff is aiming for introduction in September. They hope it can be heard in committee (Natural Resources Subcommittee of the Science Committee) this year. They told IAQU that this means people would take it seriously and work diligently on indoor air quality legislation when Congress reconvenes in January. ♦

ASHRAE Standard 62-1981R Still Not There, But...

Standard 62-1981R, Ventilation for Acceptable Indoor Air Quality, was being prepared as of August 10 for a final committee ballot before being forwarded to ASHRAE's Committee on Standards. The committee will review it and determine whether changes are substantive enough to require that the current version be submitted for another public review period. If so, adoption would be delayed at least another year. If all goes well, the ASHRAE Board of Directors could approve it at the Winter Meeting in January.

While many observers are focused on the setting of outside air ventilation requirements, members of the committee stressed that the minimum values are intended to define quantities delivered to the occupant's breathing zone, not just the quantity provided at the supply diffuser or by the supply fans. This places a considerable burden on designers to understand the type and degree of mixing which will occur, and to provide additional outside air to compensate for incomplete mixing.

Committee Chairman John Janssen said that the low flow conditions which prevail when thermostats are satisfied in variable air volume (VAV) systems will have to be compensated for by a larger fraction of outside air. He stressed that in the past most measurements of supply air delivery focused on maintenance of thermal comfort without concern for radiant heat transfer. Janssen said that up to half of thermal exchange can be from radiant transfer. His comments suggest that in the future designers will have to shift their focus from maintenance of thermal comfort to total comfort or total indoor air quality.

Committee member Dave Grimsrud, program leader for the Indoor Environment Program at U.C. Berkeley's Lawrence Berkeley Laboratory, said that most HVAC systems don't work as designed, rather than that they are not designed properly. Dr. Grimsrud's comment emphasizes the importance of developing useful methods for measuring *ventilation efficiency* as a way of quantifying the delivery of outside air to the breathing zone. Another ASHRAE committee is currently developing a standard for such methods, but those active in the process have yet to come to conceptual agreement on the approach they will use.

In the current version of the Standard 62, 15 cfm per person (cfm/p) is the minimum outside air ventilation in any occupied space. This applies to schools, stores, sleeping rooms, and lobbies in hotels, and a variety of other occupancy categories where known sources of pollutants are not present. This is a significant increase over the 5 cfm/p outside air requirement in the current standard for many occupancies without smoking permitted and a reduction from 20 cfm/p for many occupancies where smoking is permitted.

In the proposed standard 20 cfm/p is the minimum outside air supply requirement in general office space, whether or not smoking is permitted. In smoking lounges, 60 cfm/p outside air is required, while in hospital patient rooms, bowling alleys, and other occupancies where activity requires it, 25 cfm/p is specified.

Neither Janssen nor Grimsrud would predict what will occur once the committee approves and passes the proposed standard on to the Committee on Standards. We believe the design, construction, and building communities are prepared to adopt the standard for guidance as soon as it becomes available, even though there may be controversy regarding its provisions. No group has greater credibility or authority than ASHRAE in the setting of indoor air quality standards today. ♦

READERS: If you have IAQ information to share with other IAQU readers, send it to our editor Hal Levin, 2548 Empire Grade, Santa Cruz, CA 95060.

Asbestos Abatement Industry Estimated at $100 Billion

The respected construction industry weekly *ENR* (Engineering News-Record) reported in a recent cover story that the market for asbestos abatement in residences, schools, and other nonresidential buildings is projected at $100 billion. The figure is based on estimates made by EPA in its report to Congress earlier this year ("EPA Study of Asbestos-Containing Materials in Public Buildings," February 1988). According to *ENR*, the majority of the work will be performed by a small number of well-equipped, large contracting firms. Currently there are an estimated 3,000 firms gearing up to perform asbestos abatement work.

Where is the asbestos?

The EPA study estimates that about 20% of all buildings (or approximately 733,000) have some type of asbestos-containing friable material. Five percent have asbestos-containing sprayed- or trowelled-on friable material. Sixteen percent have asbestos-containing pipe and boiler insulation. Very few buildings (less than 0.5%) were found to have asbestos-containing ceiling tile. An estimated 42 percent of buildings have asbestos-containing floor tile.

Buildings built in the sixties are more likely than other buildings to have asbestos-containing sprayed- or trowelled-on friable material. And older buildings are more likely than newer ones to have asbestos-containing pipe and boiler insulation. Federal government and residential rental buildings were more likely to have asbestos-containing friable materials than private nonresidential buildings.

For more information

The EPA report is available from the Office of Toxic Substances, United States Environmental Protection Agency, Washington, D.C. 20460; (202)554-1404, or from EPA Regional Asbestos Coordinators. ♦

Products & Services

Rad Elec Inc.'s E-PERM

The newest entry in the fast-growing assortment of economical passive radon monitors is an electret in a canister called E-PERM (Electret Passive Environmental Radon Monitor). It appears to be easy to use, reliable, and economical — the qualities of a good monitoring device. It should be attractive to homeowner and professional alike.

How the Electret radon monitor works

The monitor is made from a thin piece of Teflon plastic subjected to a large electric charge, creating something analogous to a permanent magnet. When the electret is exposed to ions bearing a charge opposite to its own, they collect on the electret, decreasing its electrostatic potential. The electrostatic potential is measured before and after exposure, and it is fairly stable when the monitor is kept in the sealed container provided for its storage and transport.

Applications

Electret radon monitors can be made for short (hours or days), moderate (weeks to months), or long (months to a year) monitoring periods. The system is supplied with a voltmeter, which is used to read the monitors in the field and give results rapidly.

Advantages and a word of caution

Electrets can be used for multiple serial measurements until the electrostatic charge decreases below a certain level. The higher the levels being measured, the fewer repetitive uses possible. The monitors are returned to the provider to be recharged and used again. Alternatively, the electrets can be returned to the lab for reading and computing radon levels.

The electret system allows the radon control professional to provide the rapid responses required by many situations and an increasing number of clients. The potential for misapplication or misinterpretation of results is high with any radon monitor, and elevated radon levels should always be verified with replicate sampling and long-term sampling before extensive mitigation measures are implemented.

Rad Elec Inc., P.O. Box 310, Germantown, MD 20874-0310; (301)963-0256. ♦

Information Exchange

NIBS Report: Termiticides in Buildings

A report useful to those interested in the termiticides controversy, including the perspective of industry, is: "Termiticides in Building Protection, Proceedings of a Workshop, September 22-23, 1982, Washington, D.C.," edited by Abdallah M. Khasawinah, published February 1983. It is available from NIBS (National Institute of Building Sciences), 1015 15th St. N.W., Washington, DC; (202)347-5710. ♦

Revised NIBS Asbestos Model Guide Specifications

Architects, engineers and building owners requiring construction contract documents for construction, remodeling, or demolition in facilities containing asbestos can benefit greatly from NIBS's *Model Guide Specifications, Asbestos Abatement in Buildings*.

This document includes detailed model construction specifications language for every conceivable situation where construction might involve dealing with asbestos containing materials (ACM).

The NIBS Task Force has updated and revised the document. The revised version should be available in September 1988. It will cost $125 for the book or $175 for the book plus diskette.

NIBS, 1015 15th St. N.W., Washington, DC; (202)347-5710. ♦

Indoor Radon II

Because of the growing interest in and public concern about indoor radon, the Air Pollution Control Association (APCA), in April, 1987, sponsored the Second International Specialty Conference on Indoor Radon. The proceedings of this conference, *Indoor Radon II*, include the following:

- A current assessment of the nature of the problems;
- Issues related to health effects and risk assessment;
- The development of public and private sector initiatives;
- Research into methods of control and prevention;
- International perspectives; and
- Measurement methods and programs.

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INDOOR AIR QUALITY UPDATE™
A Practical Guide to Indoor Air Problems

As public awareness of indoor air quality grows, those who know how to make a building safer are going to be in great demand. But it isn't easy. Indoor air quality is a new and complex field. Although significant progress is being made, the available information is widely dispersed, and many questions remain unanswered. ***Indoor Air Quality Update*** is a single source of practical solutions and accurate interpretations and forecasts of technical regulatory trends. That's why each monthly issue provides analysis of legislation, regulations and litigation; hands-on tools and techniques; explanations of research findings; trends; detailed case studies; objective product reviews; and in-depth tutorials. Editor: Hal Levin. (12/year)

R-2000 *The Better-Built House*

An informative, entertaining, and practical video series on how to build quality, energy-efficient homes. Twenty 15-minute shows provide a solid understanding of the better-built house. The series, hosted by builder Oliver Drerup, will give you a complete understanding of the concepts and then show you how to put them into actual, hands-on use. You will discover that most of these methods and techniques do not require significantly more work, or incur greater costs. Topics covered by the series include: Introduction and building science (3 shows) — construction overview (2 shows) — house foundations (2 shows) — above grade envelope (5 shows) — mechanical systems (5 shows) — Involvement of the trades (2 shows) — marketing and summary (1 show). The video series includes a trainers guide and learners guide to help you put this information to use immediately.

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Moisture In Houses *Control Technology for Designers & Builders*

There are many sources of moisture in houses which can cause mildew, fungal growths, wood rot, rust, and health risks. This invaluable report will help you avoid potential moisture problems in today's airtight houses. Covers when and how to use vapor barriers, strategies for controlling humidity for health, advice on ventilation systems, problems of air-convection within walls, and much more. (34 pp)

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Principles, Practice & Available Products

Windows are holes in your house, and can be the largest source of heat loss and drafts. But, the right windows can add comfort, beauty and energy-efficiency — vital selling points — to your houses. In this complete guide you will find comprehensive information on new products, research and testing, airtightness, solar transmission properties, installation techniques, available products, and manufacturers. (31 pp)

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The material is intended for the technically oriented and for those responsible for developing programs and initiatives to address this important public health issue. Contributors include federal, state, and provincial program officials and members of the academic and private sectors.

Available from: Air Pollution Control Association. 220 pages. $50.00 ($35.00 for APCA members). APCA, P.O. Box 2861, Pittsburgh, PA 15320. ♦

Your Home, Your Health, and Well-Being

This recent release by David Rousseau, W. J. Rea, and Jean Enwright is intended primarily for the chemically sensitive individual. But, like the miner's canary, these people offer us some instruction as to where we might best not tread (or inhale). And this book has value for anyone concerned about health and buildings.

Rousseau has not only addressed indoor air quality, but also such health and physiological factors as lighting, noise, and thermal comfort. While comprehensive in scope and useful as far as it goes, the book is over-reaching the current state of knowledge and poses the danger of convincing the trusting reader that it is both complete and accurate.

In defense of the authors, the task undertaken is mammoth.

However, a serious risk is posed for the reader who relies on the book, which the book invites by its format and tone. We wish there were more acknowledgement of the information gaps which do exist and less careless rating of materials as simply A, B, and C — indicating basically stable (read "safe"), potentially unstable, and those linked with serious contamination. We found some seriously flawed ratings beyond the oversimplification inherent in such a rating system. Nonetheless, the book does provide an overview and good introduction to some important concepts, not only applicable in residential but also in nonresidential building environments.

Available from: Cloudburst Press, P.O. Box 147, Point Robert, WA 98281; (206)945-2017 (Canada) and Ten Speed Press, P.O. Box 7123, Berkeley, CA 94707; (415)845-8414 (U.S.). 300 pages, 160 illustrations. $19.95. ♦

EPA Survey of Indoor Air Companies

EPA has just sent a survey to over four thousand private companies to determine the level and nature of indoor air related business activities in the United States. The project, being conducted by ICF Incorporated of Fairfax, VA, is to help EPA respond to its mandate under SARA to coordinate government and private sector research related to improving indoor air quality. If your company did not receive a questionnaire in the mail, call EPA's Indoor Air Quality Profile Hotline at (800)727-1247 to get involved. ♦

CO_2 Monitoring: Standard Methods Development

Carbon dioxide (CO_2) is frequently monitored in indoor air to evaluate the adequacy of ventilation relative to occupancy. Yet no handy, generally accepted, reliable, and economical method exists. Detector tubes are controversial because of their reliability and accuracy at the levels of concern — 350-1,500 ppm. The direct-reading infrared devices now available are too cumbersome and expensive for many applications. The widespread use of CO_2 measurement in indoor air monitoring without standardized methods or practices may result in significant differences in results.

ASTM Subcommittee D22.05 on Indoor Air is currently seeking input for the development of a method for the measurement of CO_2. Roy Fortmann of GEOMET Technologies, Inc., chairman of the inorganic gases and vapors section of D22.05, is seeking answers to the following questions:

1. Should we develop a method specific to the non-dispersive infra red (NDIR) monitors or a practice that covers advantages and limitations of various methods?
2. What methods and monitors have you used?
3. What are the advantages and limitations of the methods and monitors?
4. What is the precision, bias, and resolution of your monitor or method?
5. What are the interferences?
6. What problems have you had with CO_2 monitors?
7. What are your measurement protocols?
8. What is your calibration procedure?

If you can assist Fortmann, write to him at GEOMET, 20251 Century Boulevard, Germantown, MD 20874, or call at (301)428-9898. If you would like more information about Subcommittee D22.05 on Indoor Air, contact Staff Manager, Subcommittee D22.05 on Indoor Air, ASTM, 1916 Race St., Philadelphia, PA 19103; (215)299-5400. ♦

Competition: Healthy House 1988 Award

You have only until September 16th to enter the competition for The First Annual Healthy House Award, which will be presented at "Blueprint for a Healthy House; Third Annual Conference for the Housing Industry." The competition is open to anyone with a product, material, technique, or strategy that helps create, maintain, or restore a healthy home environment. It must be effective, practical, and economical. For information and an official entry form call (216)281-4663. For information on on attending the conference, see the listing below. ♦

Calendar

September 7-9, 1988, **Indoor Air Quality: Evaluation, Measurement, and Control,** Harvard School of Public Health, Boston, Massachusetts. Contact: Office of Continuing Education, 677 Huntington Ave., Boston, MA 02115; 617-732-1171.

September 19-20, 1988, **Indoor Air Quality Conference,** State Department of Health, Seattle, Washington. Contact: James O. White, DSHS/Health Services Division, Toxic Substances Section, Mail Stop LD-11, Olympia, WA 98504; 206-753-2556 or 206-586-4501.

September 20-21, 1988, **Radon Conference,** American Association of Radon Scientists and Technologists, Hyatt Regency Hotel, Bethesda, Maryland. Contact: Michael Terpilak, AARST Mid-Atlantic Chapter, 10400 Connecticut Avenue, Suite 504, Kensington, MD 20895; 301-933-7900.

September 20-23, 1988, **Indoor Air Quality Symposium and Optional Workshop on Sampling and Analysis Techniques,** Georgia Tech Research Institute, Atlanta, Georgia. Contact: Continuing Education Department, Georgia Tech, Atlanta, GA; 404-894-2400

October 12-14, 1988, **Blueprint for a Healthy House,** Cleveland, OH. Contact: Housing Resource Center, 1820 W. 48th St., Cleveland, OH 44102; 216-281-4663.

October 18-21, 1988, **EPA 1988 Symposium on Radon and Radon Reduction Technology,** Sheraton Denver Tech Center, Denver, Colorado. Contact: Barbara Emmel, Radian Corporation, P.O. Box 13000, Research Triangle Park, NC 27709; 919-541-9100.

October 18-21, 1988, **Monitoring and Control of Toxics and Criteria Pollutants,** The State of the Art, Mid-Atlantic States Section, APCA, Sands Hotel and Country Club, Atlantic City, NJ. Contact: Dr. Joseph J. Soporowski, 201-932-9444.

November 7-9, 1988, **ASTM Subcommittee D22.05, Indoor Air,** Atlanta Hilton & Towers, Atlanta, Georgia. Contact: Sharon Kauffman, ASTM, 1915 Race Street, Philadelphia, PA 19103; 215-299-5599.

November 9, 1988, **Symposium on Indoor Air Quality Measurements,** Southeast Regional Meeting, American Chemical Society, Radisson Hotel, Atlanta, Georgia. Contact: David W. Boykin, Chemistry Dept., Georgia State University, Atlanta, GA 30303; 404-651-3120.

January 28-February 1,1989, **ASHRAE Winter Meeting and Exhibition,** Chicago, Illinois. Contact: Jim Norman, ASHRAE, 1791 Tullie Circle, N.E., Atlanta, GA 30329; 404-636-8400.

February 3-4, 1989, **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.

April 17-20, 1989, **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.

June 20-24, 1989, **ASHRAE Annual Meeting,** Vancouver, British Columbia. Contact: Jim Norman, ASHRAE, 1791 Tullie Circle, N.E., Atlanta, GA 30329; 404-636-8400.

July 16-19, 1989, **Symposium on Biological Contaminants in Indoor Environments,** ASTM Subcommittee D22.05 on Indoor Air, Boulder, Colorado. Contact: Staff Manager, Subcommittee D22.05 on Indoor Air, ASTM, 1916 Race Street, Philadelphia, PA 19103; 215-299-5400.

INTERNATIONAL

September 5-8, 1988, **Healthy Buildings '88,** Stockholm, Sweden. Contact: Gunilla Norbro, Swedish Council for Building Research, St. Goransgatan 66, S-112 33 Stockholm, Sweden; 46 8 54 06 40.

February 14-16, 1989, **Present and Future of Indoor Air Quality,** Belgian Ministry of Public Health, Brussels, Belgium. Contact: D. Shanni - E.C.C.O.sprl, 17 A Rue Vilain XIIII, B-1050 Brussels, Belgium

September 1, 1989, **CLIMA 2000, the Second World Congress,** Sarajevo, Yugoslavia. Contact: CLIMA 2000, Massinski Fakultet, Prof. Dr. Emin Kulic, 71000 Sarajevo, Omladinsko Setaliste bb, Yugoslavia.

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