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Indoor Air Quality Update®

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

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How Office Furnishings and Equipment Affect IAQ

Modern offices often contain large numbers of workstations separated by partitions that afford some degree of acoustical and visual privacy to workers. These workstation setups and the equipment they contain contribute to a number of IAQ problems — both as sources of pollutant emissions and impediments to ventilation effectiveness. In many office buildings, furnishings and equipment have become the predominant indoor sources of airborne contaminants. In floorplans with large mazes of workstations, contaminant concentrations can become elevated enough to affect workers' health and comfort. The impact of furnishings and equipment on IAQ is often amplified by the large volume of sources involved, as well as by the workers' proximity to the sources and by the lack of diluting air circulation within the workstation units.

Environmental health officials advocate source control as the most effective approach for improving IAQ, but the current lack of standards on emissions and product testing make selection of furnishings and equipment difficult. Information on actual emissions rates and the associated health impacts is also incomplete at this time. But armed with our current knowledge of furnishings and equipment emissions, owners and managers of commercial buildings can still take steps to reduce the impact of those emissions through a combination of source control and ventilation control. [A new report, ***Office Furnishings/Equipment & IAQ***, is available from Cutter Information Corp. Please see page 16 for more information.]

IN THIS ISSUE

Emissions From Office Furnishings

A number of researchers have focused their attention on testing furnishing products to determine which may contribute the most to indoor concentrations of air contaminants. Perhaps more than anything else, results from emissions testing on furnishings and on the materials used in their production have shown that emissions levels vary considerably depending on a number of factors — product age, manufacturing source, and especially, testing conditions and measuring techniques. It is the latter that has made it essential for manufacturers and regulatory agencies to establish emissions testing standards before mandating routine testing of all products.

While researchers have avoided making definitive statements on specific emission levels for particular furnishing products, they agree on a number of general conclusions:

- *Pressed-wood products, such as those used in desks and shelving, emit formaldehyde.* The highest emissions are from medium-density fiberboard (MDF) and particleboard, and other products containing urea-formaldehyde resins. Products containing phenol-formaldehyde resins have only one-tenth the off-gassing potential of MDF.
- *Formaldehyde emissions tend to decrease with product age.* The highest concentrations of formaldehyde are emitted from furnishings in the first days or weeks after installation. The half-life of formaldehyde appears to be about 4.4 years.
- *Formaldehyde emissions from pressed-wood products increase with heat, relative humidity, and ventilation rate.* Temporarily elevated airborne concentrations of formaldehyde often occur in the summer months.
- *Furnishings emit a large number of other volatile organic compounds (VOCs) in lower concentrations.* While formaldehyde emissions tend to predominate, researchers have also identified a number of other VOCs emitted by furnishings, including acetone, benzene, hexanal, butanol, 2-butanone, and benzaldehyde.
- *Coatings, treatments, and cleaners used on furnishings can also emit significant concentrations of VOCs.* The greatest portion of airborne contaminants from these sources is emitted while the products are still wet.
- *Fabric draperies and furnishing coverings can emit significant quantities of VOCs.* Treatments used to increase the stain-, wrinkle-, and fire-resistance of fabrics can emit formaldehyde and dozens of other VOCs. Dry-cleaned fabrics emit perchloroethylene.

Sink Effects in Furnishings

In addition to their role as primary sources of emissions, furnishings, particularly upholstered furniture and fabric-covered modular partitions, can become sinks and secondary emitters of bioaerosols and VOCs from other sources. Again, research in this area has netted varied results, but we can reasonably draw a few conclusions from what is currently known:

- *Fleecy furnishings can adsorb and later re-release VOCs originating from other sources.* Environmental tobacco smoke and VOCs emitted from other sources, such as freshly applied paints or cleaning products, can be adsorbed by fabric coverings of upholstered furniture and modular partitions and re-emitted later. The furnishings thus become secondary sources of VOCs that may originate from temporary activities, such as painting or cigarette smoking, even after these activities have ceased.
- *Sorption and re-release of VOCs vary with temperature and ventilation rate.* Sorption of VOCs tends to be higher at lower ventilation rates, since the VOC molecules are in contact with the sorptive surfaces for a longer time. The emission of these compounds from their primary sources and their re-release from sorptive surfaces increase with temperature. Sorption can become particularly pronounced during times of higher temperature and low ventilation, such as during the weekend shutdown of HVAC systems during the summer. Re-release of sorbed compounds can then peak when HVAC systems are turned on again and ventilation is increased.
- *Upholstered furniture and fabric-covered partitions can harbor dust mites, fungi, and bacteria.* Fabric coverings, seating cushions, and acoustical backings of partitions can become growth matrices for fungi, dust mites, and microorganisms, particularly under conditions of high temperature and high relative humidity. Furnishings can in this way become sources of allergens.

Workstation Setups and Ventilation

In addition to their role as primary and secondary pollutant sources, office furnishings arranged into modular workstations can amplify ambient pollutant concentrations by impeding air circulation. Most air handling systems are designed for open, unobstructed space and cannot adequately distribute air to all spaces in rooms with large numbers of partitions and tall furnishings. Airborne contaminants, such as carbon monoxide, carbon dioxide, VOCs, and particulates, can become concentrated in "dead spaces" created by furnishing arrangements.

Health Effects From Furnishing Emissions

As potent emitters of VOCs and occasionally of bioaerosols, furnishings can have a significant impact on the IAQ of commercial buildings. Poor IAQ can, in turn, significantly impact the health and comfort of building occupants who may spend more than 40 hours a week exposed to furnishing emissions. Virtually no documentation exists of direct correlations between furnishing emissions and health effects. But researchers have indirectly correlated furnishings with known health effects associated with specific contaminant emissions, particularly formaldehyde.

Formaldehyde

The health effects from formaldehyde depend on the levels of exposure and on the individual sensitivities of exposed subjects. Though epidemiological research into the short- and long-term effects of formaldehyde is still inconclusive, environmental health researchers have drawn a number of tentative conclusions:

- *Formaldehyde can irritate the mucous membranes of the eyes, the upper respiratory tract, and skin, even at relatively low concentrations.* Many people appear to experience irritation even when the odor of formaldehyde is imperceptible.
- *Formaldehyde may have neurological effects at low and moderate levels of exposure.* Some researchers report neurological effects, such as memory loss, headaches, mental confusion, and anxiety, even at low exposure levels in highly sensitive individuals. But many observers argue that the subjective nature of some of these symptoms make it difficult to determine the threshold of neurological effects in healthy individuals.
- *Higher concentrations of formaldehyde may cause more serious cardiovascular and pulmonary effects.* While concentrations of formaldehyde may rarely reach levels at which more serious health effects are a concern, levels can become temporarily elevated during the installation of a large number of new furnishings, and affect high-risk populations, such as children, pregnant women, or individuals with pre-existing cardiac or pulmonary impairment.
- *The human carcinogenicity of formaldehyde is still not clearly established.* Most health officials agree that the potential for developing cancer as a result of exposure to the levels generally found in nonindustrial settings is very low. Many are, however, of the mind that since we are still uncertain as to the carcinogenic potential of formaldehyde, we should probably minimize exposure as much as possible.
- *A few researchers have implicated furnishings as triggers of multiple chemical sensitivity* (MCS). Some anecdotal evidence suggests that the formaldehyde from pressed-wood furnishings may trigger MCS or cause sensitive reactions in individuals already diagnosed with MCS.

Other VOCs

Health researchers link a number of the other VOCs commonly found in furnishings with health problems, though most of these effects would occur at levels of exposure higher than those expected in office environments.

- *Some VOCs found in furnishings act as central nervous system depressants.* These compounds include xylene, trichloroethylene, methylene chloride, 2-butanone, and perchloroethylene.
- *Some VOCS emitted by furnishings act as irritants or narcotics.* Benzene, perchloroethylene, 2-butanone, and xylene can irritate the skin, eyes, and upper respiratory tract. Toluene, xylene, and methylene chloride can act as narcotics.
- *Some VOCs emitted from furnishings are potential human carcinogens.* While only benzene is a confirmed human carcinogen, several compounds found in furnishing emissions are suspected carcinogens, such as methylene chloride, chloroform, carbon tetrachloride, 1,2-dichloroethane, trichloroethylene, and perchloroethylene.
- *Some investigators consider furnishings, as emitters of VOCs, to be important contributors to sick building syndrome.* In a number of case studies of sick buildings, experts have implicated furnishings as primary causative agents, particularly in new installations.

Regulations and Standards for Furnishing Emissions

Setting and enforcing emissions standards for furnishing products could significantly improve IAQ in office buildings. But it may be years before such standards become reality.

Currently in the US no relevant regulations are in force. Manufacturing groups have made some efforts to establish voluntary standards for formaldehyde content in pressed-wood products, in cooperation with the Consumer Product Safety Council, but many observers are concerned that these standards may not be sufficiently protective. In the fall of 1991, the US Environmental Protection Agency (EPA) announced that it was considering consumer labeling and emissions standards for furnishings made with urea-formaldehyde resins. The IAQ legislative bills currently under consideration by the US House and Senate contain provisions regarding the testing and regulation of emissions from building materials and furnishings.

A few other nations are also considering testing and labeling of furnishing products. Currently, Germany appears to be at the forefront of efforts to regulate emissions and establish a labeling system for "environmentally safe" products (see ***IAQU***, January).

Mitigation Techniques for Furnishing Emissions

Until emissions standards are in place, it is up to building owners to develop their own strategies for mitigating IAQ problems associated with furnishings. No one mitigation technique will completely eliminate all indoor contamination from furnishings. The most effective strategy will involve a combination of source control and ventilation techniques. The best approach will depend on a number of factors — the extent of the emissions problem, the sensitivity and concerns of building occupants, the economic and technical resources available, the extent to which mitigation may disrupt business, and management concern about litigation.

Source Control

To reduce emissions through source control, building owners and others responsible for IAQ can take the following preventive steps:

- *Select lower-emitting furnishing products.* With no labeling or testing standards, we have to rely on manufacturers' information to determine the relative emissions levels of different products. Unfortunately, much of this information may be unreliable or incomplete (***IAQU***, March 1989). Gene Tucker of the EPA has published a number of tentative guidelines, including the recommendation that no product should contribute more than 0.05 mg/m^3 to the overall concentration of total volatile organic compounds (TVOCs). Tucker also recommends that movable partitions not exceed 0.4 mg/hr per m^2 in TVOC emissions and that office furniture not exceed 2.5 mg/hr per workstation in TVOC emissions (***IAQU***, January and August 1990). Purchasers must take an active role in working with manufacturers and suppliers to make appropriate choices for furnishings.
- *Work with manufacturers to precondition furnishings.* Since newly manufactured furnishings generally off-gas a major portion of their lifetime emissions within the first few hours, days, or weeks after removal from packaging, allowing the products to air out prior to installation can greatly reduce worker exposure to emissions. This can be accomplished by: allowing the products to air out in clean, dry, and well-ventilated storage areas before packaging for shipment; increasing the temperature and ventilation of storage facilities to increase off-gassing; shipping products in permeable packaging in well-ventilated vehicles; and increasing ventilation during installation.
- *Conduct a bake-out procedure after installation.* A bake-out involves raising the temperature of a building to the point that VOC emissions from building materials and furnishings are accelerated, and increasing the outdoor air exchange to exhaust emissions from the building. Researchers employing this technique on furnishings have had mixed results. Successful bake-out setups require raising temperatures above 32°C (90°F) for at least four full days. They also require proper manipulation of HVAC systems to provide enhanced outdoor air exchange rates, while simultaneously raising the temperature. Most experts recommend seeking professional assistance before conducting a bake-out.
- *Apply sealants to furnishing surfaces to minimize emissions.* Thin coatings of laminates or veneers and liquid coatings of sealants can help to reduce or even eliminate emissions from pressed-wood surfaces. Some wet sealants can, however, be significant sources of VOCs themselves, but usually only during application, curing, and drying.
- *Prevent sink effects in furnishing surfaces.* Protecting furnishings with polyethylene plastic sheets during temporary activities that result in high emissions, such as the installation of new carpeting or painting, can reduce the possibility of sorption. Prevention of microbial contamination involves implementing efficient housekeeping practices and protecting furnishings from water contamination and high humidity.

Ventilation Control Measures

Source control measures are not always practical or economically feasible, and in many cases may also be insufficient to reduce airborne contaminant levels. Building managers may need to modify ventilation to effectively dilute contaminant concentrations, particularly during temporary fluxes of emissions with increased temperature or after new installations.

We can use two basic strategies in ventilation improvement — contamination dilution, and isolation and removal of contaminants. Since it is impractical to separate building occupants from the sources of emissions in the case of furnishings, diluting contamination by increasing ventilation rates to those recommended by ASHRAE 62-1989 may be the best strategy.

Improving ventilation and reducing "dead air spaces" at workstations presents a special challenge to building managers. Ventilation effectiveness can be improved a number of ways, depending on building and HVAC designs. Many experts recommend periodic testing, adjusting, and balancing to overcome ventilation effectiveness problems.

Emissions From Office Equipment

Office equipment, such as dry- and wet-process copying machines, laser printers, and computer terminals, place an additional burden on the already poor IAQ of many office buildings, by emitting a number of VOCs and ozone. Researchers and IAQ investigators conducting chamber testing and case studies have made several general observations about office equipment emissions:

- *Wet-process photocopiers emit a small amount of VOC-containing solvent with each copy.* The emissions include a number of VOCs with potential health impacts: xylene, branched alkanes, phthalates, isocyanates, nitropyrene, and 2,2,4-trimethyloctane. In buildings with large numbers of copying machines, such as libraries, photocopiers can be a major source of VOCs, making up as much as 90% of the TVOC concentration.
- *Electrical equipment, such as computer terminals, printers, and fax machines, can also release a number of VOCs.* VOCs detected in the emissions of electrical equipment include benzene, trichloroethylene, styrene, methyl chloroform, ethylbenzene, perchloroethylene, and 1,2-dichloroethane.
- *Office machinery is the major indoor source of ozone in office buildings.* Electrical equipment, computer terminals, laser printers, and dry-process photocopiers can emit substantial quantities of ozone in some situations. These emissions increase the already elevated ozone levels from outdoor sources in urban settings.
- *High densities of equipment and/or deficiencies in ventilation systems can create elevated indoor ozone levels.* Elevated indoor ozone levels from both indoor and outdoor sources can lead to adverse health effects in building occupants.

Health Impacts From Equipment Emissions

The health effects from exposure to elevated VOC concentrations from equipment emissions are similar to those we mentioned for furnishings emissions. Only a few research studies have focused directly on the health effects of the VOCs emitted by office equipment. These studies document isolated cases of allergic responses, rhinitis, laryngeal swelling, and pharyngeal spasms.

There has been greater concern about the effects of ozone emissions. As a strong oxidant, ozone can have a variety of physiological effects on pulmonary function, as well as act as an irritant. The health impacts associated with exposure to the elevated levels of ozone often found in buildings with large volumes of office equipment include: eye irritation, shortness of breath, coughing, asthma, mucous membrane irritation, and chest pain with inhalation. Individual sensitivity to ozone varies considerably. Some health officials are concerned about the potential carcinogenicity or cocarcinogenicity of ozone, although we currently have little evidence to substantiate this.

Emissions Standards for Office Equipment

Governmental action to set equipment emissions standards has been slow. The US currently has only the guidelines recommended by Tucker and the EPA: for centrally located office machines, 0.25 mg of VOCs/hr/m^3 of workspace, and 0.01 mg of ozone/hr/m^3 of workspace, and for personal-use office machines, 2.5 mg of VOCs/hr/workstation, and 0.1 mg of ozone/hr/workstation.

Underwriters Laboratories (UL) independently developed voluntary standards for ozone emissions and guidelines for worker exposure to equipment emissions. Some manufacturers have begun including replaceable ozone filters in new equipment and providing ozone emissions information for consumers in equipment product manuals.

Mitigation Techniques for Equipment Emissions

Building owners and office managers can take a number of practical preventive measures to reduce worker exposure to ozone and VOC emissions from office equipment:

- *Select lower-emitting equipment in consultation with manufacturers and authorities on emissions guidelines.* This strategy may require equipment purchasers to take an active role in requesting emissions data from manufacturers.
- *Minimize the use of equipment when possible.* This measure could include turning off machines that are not in use for long periods of time, or scheduling extended copying or printing jobs for times when the majority of workers are not present.
- *Ensure that all workers and equipment operators are educated in the proper use and maintenance of equipment.* Improperly used or maintained equipment can cause elevated emissions levels.
- *Remove emissions at the source through ventilation.* The most effective strategy for reducing ambient levels of ozone and VOC emissions from office equipment is to isolate the equipment in special rooms with customized ventilation systems that provide increased outdoor air, eliminate recirculation of air to other areas of the building, and include additional exhaust systems. When equipment isolation is not feasible, locating equipment in well-ventilated rooms or within 10 feet of return air ducts can also be effective.
- *Remove emissions at the source through filtration.* Some authorities recommend the use of ozone filters and VOC filters on or near equipment to remove emissions.

Conclusions

By themselves, emissions from office furnishings and equipment probably do not often present serious health risks to building occupants. But when added to the emissions from other indoor sources, such as carpeting, wall paints, and cleaning products, and coupled with inadequate ventilation, they can contribute to the development of problems such as sick building syndrome.

A number of obstacles need to be overcome before environmental regulatory agencies, manufacturers, and building managers can most effectively protect office workers from IAQ problems associated with furnishings and equipment. Emissions testing needs to be standardized. Health researchers need to make more direct connections between emissions levels and health effects to determine "safe" levels of airborne contaminants. Consumers need to educate themselves on environmental health concerns. Manufacturers need to respond to the increasing consumer demand for lower-emitting products.

Until source control becomes more feasible through the increased availability of safer products, building owners need to take all possible preventive measures, particularly in ventilation control, to improve IAQ in office buildings.

PRACTICAL RESEARCH BRIEFS

When to Install Demand-Controlled Ventilation

Before the early 1970s, buildings typically depended on constant-air-volume HVAC systems. After the energy crisis, building managers turned to variable-air-volume (VAV) systems to cut down on energy costs. In the past few years, we have seen research on and marketing of a new technology: demand-controlled ventilation (DCV). Conceptually, DCV is similar to VAV systems in that a certain condition of a building's occupied space regulates the amount of air brought in by the HVAC system. In a VAV system the temperature of the occupied space regulates ventilation rates. In DCV the level of contamination in the air determines how much supply air will be brought into the building. The purported advantage of DCV is increased energy savings while maintaining good IAQ. But one researcher suggests that this advantage from DCV will only accrue under certain conditions.

Annex 18: DCV Is...?

Though the concept behind DCV is straightforward, a standard definition of the term is elusive. Annex 18, one of the 22 "projects" sponsored by the International Energy Agency (IEA) under its Energy Conservation in Buildings and Community Systems program, has done extensive work on DCV. (The IEA sponsors the projects to "more accurately predict the energy use of buildings." See ***IAQU***, March, for more information on the IEA.)

In the introduction to a report on DCV, Annex 18 defines DCV as "a ventilation system in which *mental Technology* (Volume 13, No. 4, Selper, Ltd, London, UK). Contact: Fariborz Haghighat and Giovanna Donnini, Centre for Building Studies, Concordia University, Montreal, PQ H3G 1M8, Canada.

The *12th Annual AIVC Conference Proceedings* contain both Bob Davidge's article, "Demand Controlled Ventilation Systems in Office Buildings," and "Demand Controlled Ventilation: Evaluation of Commercially Available Sensors," by Fahlén, Andersson, and Ruud.

Bob Davidge, Public Works Canada, Architecture and Engineering Services, Sir Charles Tupper Building, Riverside Drive, Ottawa, ON K1A OM2, Canada; (613) 736-2123.

Per Fahlén, Helena Andersson, and Svein Ruud, Swedish National Testing & Research Institute, Box 857, S-501 15 Borås, Sweden; +46 33 165000.

CASE STUDY

*In each issue **IAQU** presents a case study on an investigation of indoor air problems in a particular building. The editorial staff relies on information provided by the environmental consultants involved in the investigation. **IAQU** presents a variety of approaches to investigation and mitigation implemented by consultants with a broad range of experience, philosophies, and expertise. Inclusion of a particular case study in the newsletter does not imply **IAQU**'s endorsement of the investigative procedures, analysis, or mitigation techniques employed in the case. **IAQU** invites readers to submit comments, suggestions, and questions concerning any case. At the discretion of the editors, correspondence may be presented in a future issue.*

Problems in a Midwestern School Building

In early 1992, two employees and several students at a Midwestern school complained of eye, nose, and throat irritation, allergic type responses, and breathing difficulties upon entering the school building. The symptoms subsided when the affected individuals left the building. Maintenance personnel originally attributed the problem to inadequate cleaning of the high levels of dust in the building. After implementing stricter cleaning practices, however, complaints of medical problems persisted. At this point, the school contracted with an inspection firm to investigate the situation.

Building and HVAC System Design

The one-story school building is approximately 18,000 square feet, housing an office area, kitchen area, and approximately 12 kindergarten classrooms. The building was constructed in the 1950s.

Originally, the building utilized a central boiler with hot steam/water pipes extending to all areas of the building. The building did not contain a ventilation system, and windows were nonoperable. During extensive renovations in the late 1980s, workers removed the steam heating system and retrofitted each classroom with a thermostatically controlled heating and air-conditioning unit. The intake grilles of the units were located approximately 1 ½ feet above the ground surface on the exterior of the building. In classrooms where a complaint had occurred, the intake grille was facing a playground or, in one case, a drive-through bank. Workers also installed operable windows in the building, as part of a general school-system-wide policy of improving building IAQ.

Building Investigation

Investigators initially conducted a walk-through inspection of the building, surrounding grounds, and mechanical system. During the inspection, the investigators monitored for carbon dioxide, relative humidity, and temperature. They further inspected for any possible sources of contamination, and examined the locations of fresh air intake for the HVAC units.

Findings

The investigators noted that the individual HVAC units for the classrooms were connected directly to the outdoors and that they *were designed* to supply a certain amount of fresh air whether they were in the heating or cooling mode. They found that the units were operating with completely closed dampers when in the heating mode. Thus, the units were not supplying any fresh air and the rooms were operating on 100% recirculated air.

In addition, the investigators found that the spun fiberglass filters in the units were of very poor quality. Original installation of the filters

IAQU will report on the results of these mitigation efforts in a future issue.

For More Information

The investigative firm contracted for this inspection was Holcomb Environmental Services. Contact Barry Seabrook, Holcomb Environmental Services, 17375 Garfield Road, Olivet, MI 49076, USA; (616) 763-9463, Fax: (616) 763-9187.

NEWS AND ANALYSIS

FTC Charges "Indoor Greenhouse" Manufacturer for Misleading IAQ Advertisements

Last month, the US Federal Trade Commission (FTC) charged Pyraponic Industries II, Inc. and its owner, Jeffery Julian DeMarco, for falsely representing the capabilities of the "Phototron" indoor greenhouse. Pyraponic has agreed to a consent agreement with the FTC that prohibits Pyraponic and DeMarco from representing the Phototron (or any similar product) as capable of removing all indoor air contaminants. The consent agreement, which appeared this month in the *Federal Register* for comment, also prohibits the company from making unsubstantiated claims about any performance characteristics for any air-cleaning device. Finally, the agreement requires the company to have competent and reliable scientific evidence to support any claims that such a product reduces indoor air contamination, is superior to any other air-cleaning product, or is effective within any stated area.

The FTC found that Pyraponic's unsubstantiated claims for the Phototron indoor greenhouse included:

- "Removes: radon, formaldehyde, pet odors, kitchen & bathroom smells, cigarette smoke";
- "At the same time, your system will replenish oxygen 33 times, along with the fresh scent of the plants of your choice. In addition, the Phototron III will remove other various toxic gases ranging from carbon monoxide to sulfur to hydrocarbons";
- "You only need one Phototron to filter and clean 1,000 cubic feet of air in your home for $399.95, or 10 6-foot fichus trees at $199.95 each, equaling nearly $2,000."

According to the FTC, the company had advertised that more than 100,000 consumers had purchased the greenhouse for approximately $400 each.

Howard Shapiro, an FTC representative, told ***IAQU*** that this action is the second IAQ-related case the FTC has taken any action on, and added that the FTC is getting a "slow but steady foot in the door" on IAQ issues.

IAQU was unable to contact either the company or DeMarco by phone. Pyraponics Industries II, Inc., 15090 Avenue of Science, P.O. Box 27809, Carmel Mountain Ranch, San Diego, CA 92128, USA.

Copies of the complaint, consent agreement, and an analysis to assist the public in commenting are available from the FTC's Public Reference Branch, Room 130, Federal Trade Commission, Washington, DC 20580, USA; (202) 326-2222.

IAQ in Japan

Last December, the *First International Conference on Human-Environment System (ICHES) '91* took place in Tokyo, Japan. The conference included a strong emphasis on IAQ, as well as other indoor environmental topics. A joint meeting of the *First International Symposium on Man-Thermal Environment Systems* and the *First International Congress of Physiological Anthropology*, it was organized with assistance from the Japanese Society of Physiological Anthropology.

A broad range of Japanese organizations participated, indicating a serious commitment to indoor environmental issues in that country. Thirty-four Japanese professional societies were listed as sponsors; the Japan Ministry of Health and Welfare, the Science Council of Japan, and

Tokyo Metropolis were supporters; and 43 Japanese companies were approvers. Members of the organizing committee were Japanese except for one representative from each of the following countries: Australia, Canada, Denmark, Germany, Korea, and the US.

The conference was the latest development in an extensive history of Japanese research on factors affecting human physiology and psychology, including the indoor environment. In 1974, the Society of Heating, Air-Conditioning and Sanitary Engineers of Japan established a Subcommittee of Thermal Sensation, and in 1977, held the *First Symposium on Man-Thermal Environment Systems*. Meetings have continued annually with the assistance of the Science Council of Japan.

According to the conference organizers, the meetings have strengthened communication between researchers of medical science, physiology, human engineering, air conditioning/sanitary engineering, clothing hygiene, architecture, control engineering, heat transfer engineering, and engineers engaged in industries including residential construction, textile, air-conditioning systems, control equipment, and fire fighting. The organizers state that the annual symposium has been the "re-start" of study taking "human characteristics as the base."

The conference proceedings (632 pages) contain papers on topics including "Interconnection Between Energy Conservation in Buildings and Indoor Air Quality" and "Thermal Comfort and Indoor Air Quality Created by CO_2-Based Ventilation Control." The proceedings are available at a cost of ¥20,000. For more information, contact Dr. Yutaka Tochihara, Secretary General of ICHES '91, c/o Department of Physiological Hygiene, The Institute of Public Health, 4-6-1 Shirokanedai, Minato-ku, Tokyo, 108, Japan; Fax: +81 3 3446 4635.

IAI Activities Worldwide

In April, Indoor Air International (IAI) held its second international conference in Athens, Greece. Dr. John Dilley of IAI told ***IAQU*** that approximately 70 participants attended the conference, representing more than 27 countries. Dilley said the group "epitomized IAI" in its highly multidisciplinary character, consisting of statisticians, occupational physicians, researchers, architects, and professionals from many other disciplines. (For more information on IAI, see ***IAQU***, April and May 1990, June 1991.)

The 706-page conference proceedings consist of 66 papers separated into 9 general categories:

- Regulatory and research policy;
- Indoor air quality in relation to heating, cooling, and ventilation;
- Airborne bacteria, molds, and fungi;
- Chemical pollutants, sources, interactions, and dispersion;
- Analytical methodology in relation to exposure;
- Health effects and risk assessment;
- Computer simulation, modeling, and prediction;
- Case studies on indoor air quality; and
- Case studies on sick building syndrome.

Paper topics range from "European Communities Research Activities in the Field of Environment and Indoor Pollution" to "The Metabolism of 1-MN-Methylanabasine: A Potential Marker for Environmental Tobacco Smoke Exposure."

Last November, IAI's *International Symposium on Indoor Air Quality in Asia* covered problems such as vehicle exhaust, incense burning, and cooking as IAQ contaminant sources. The conference was a satellite of the 13th *Asian Conference on Occupational Health*, held in Bangkok, Thailand. The IAI cited the symposium as an "excellent example of multidisciplinary approach," which included architects, ventilation engineers, statisticians, pathologists, toxicologists, and analytical chemists. A volume of proceedings from the conference may be available at the end of the year.

In Poland, the IAI has been involved in two conferences on IAQ. The first, also last November, was the first interdisciplinary meeting on IAQ in Poland, and was sponsored by the Institute of Heating and Ventilating of the Warsaw University of Technology. The second meeting took place in January, and was jointly sponsored by IAI and the European Respiratory Society (ERS). Approximately 65 physicians and medical scientists, along with ventilation engineers, hygienists, and other professionals, took part in the symposium. Papers at the conference focused on IAQ and health issues.

Proceedings from the Athens conference are available to IAI members for £25 (about $40). For more information, contact IAI, Postfach 2, CH-4467, Rothenfluh, Switzerland. For information on the proceedings, contact IAI, P.O. Box 460, Biggleswade, Bedfordshire SG18 OAW, UK; +44 767 31847, Fax: +44 767 313929.

RECENT PUBLICATIONS

Understanding Indoor Air Quality

Bradford O. Brooks and William F. Davis
189 pages, $55, 1992, CRC Press, 2000 Corporate Blvd. NW, Boca Raton, FL 33431, USA

The authors of *Understanding Indoor Air Quality* have written a relatively slim volume that nevertheless gives the reader a comprehensive introduction to IAQ. The volume is well written and can easily be read straight through. The six chapters are: The Problem with Indoor Air; What Causes Indoor Air Pollution; What Health Effects Result From Indoor Air Pollution?; Indoor Air Sampling Methods; Indoor Air Quality Case Histories; and How Are IAQ Problems Actually Solved? The volume also includes a helpful index. The book contains 12 case histories that offer a broad range of practical perspectives on IAQ problems. And even though the last chapter on solving IAQ problems is only 21 pages, it contains an excellent outline of how IAQ problems can be resolved. Though IAQ professionals will probably not find any new information in the book, *Understanding Indoor Air Quality* is perhaps the strongest introductory IAQ book on the market.

Indoor Air Pollution: Problems and Priorities

George B. Leslie and Frank W. Lunau, Editors
329 pages, $79.95, 1992, Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211, USA

This is a book on problems, not solutions. However, if successfully defining a problem is half the solution, *Indoor Air Pollution* is a good start. According to the editors, the aim of the book is to "provide a balanced account of the health risks associated with these major pollutants and to quantify the scale of the problem on a pollutant-by-pollutant basis." Chapters examine the following indoor environmental problems:

- Legionella;
- Nitrogen oxides;
- Mineral fibers;
- Radon;
- Formaldehyde;
- Solvents;
- Pesticides;
- PCBs;
- Vegetable dusts;
- Danders;
- Environmental tobacco smoke;
- Extremely low-frequency electromagnetic radiation;
- Bacteria;
- Fungi; and
- Other microorganisms.

Separate chapters also address the perception of IAQ, contributions from outdoor pollutants, and ventilation for control of airborne pollutants. While on the surface it seems to be a bound edition of conference proceedings (18 authors contributed), the book is systematic and cohesive.

Measuring Indoor Air Quality: A Practical Guide

John E. Yocom and Sharon M. McCarthy
228 pages, $89.95, John Wiley & Sons, Inc., One Wiley Drive, Somerset, NJ 08875, USA

This volume is part of the "Principles and Techniques in the Environmental Sciences" series from Wiley & Sons. According to the Series Introduction to this volume, "Most environmental texts concentrate on the 'what' but not on the 'how' and on theories rather than practice." This book, however, is decidedly on the "how" of IAQ monitoring. After a discussion on planning IAQ measurement programs and building dynamics, the authors cover methods for measuring:

- Carbon monoxide;

- Carbon dioxide;
- Nitrogen dioxide;
- Sulfur dioxide;
- Ozone;
- Respirable particulate matter;
- Lead;
- Radon;
- Formaldehyde;
- Volatile organic compounds;
- Environmental tobacco smoke;
- Pesticides;
- Odors; and
- Bioaerosols.

The volume is comprehensive and well organized; we wonder why the publishers did not market it as a "handbook." ***IAQU*** recommends the book for IAQ investigators of any level of experience.

Also of Note...

- Indoor Air International (IAI) has published a bound volume of proceedings from its second international conference. See the article on IAI activities on page 9 for more information.
- The April edition of the journal *Environmental Technology* focuses on IAQ. Ten papers focus on IAQ health effects, ETS, demand-control ventilation, mineral fibers, and several other IAQ issues. For more information, contact Publications Division, Selper Ltd., 79 Rusthall Avenue, Chiswick, London W4 1BN, UK.
- INFORM, Inc., a nonprofit research organization on practical actions for the protection and conservation of natural resources and public health, has produced a report, *Tackling Toxics in Everyday Products*. The report is primarily a directory of groups working to protect health and environment from toxics found in everyday life.

  The directory is divided into two parts: 1) general descriptions of each organization (in alphabetical order), and 2) an index of subjects (e.g., indoor air pollution, arsenic, groundwater pollution) with listings of concerned organizations. For example, approximately 80 organizations are listed as being involved in some capacity with indoor air pollution; each of these organizations is also described in the main part of the directory.

  Short chapters before the directory section cover the following topics: the multiple effects of toxic chemicals in products, the "information gap" on product risks, examples of products and chemicals of concern, and a chapter on what is being done to improve the current situation. Under "products of concern," survey respondents listed building and furnishing products more often than any other product. (Home pesticides, coatings, and cleaning products were next.) Formaldehyde, lead, solvents, and volatile organic compounds received the highest listing for chemicals of concern. Ninety-six percent of the respondents supported mandatory product standards as a way to limit risks from toxic chemicals in products. The report is $19.95 plus $3 postage and handling, from INFORM, 381 Park Avenue South, New York, NY 10016, USA; (212) 689-4040.
- Oak Ridge National Laboratory and the Building Thermal Envelope Coordinating Council of the National Institute of Building Sciences (NIBS) has produced the document *Bugs, Mold & Rot: Proceedings of the Moisture Control Workshop*. The report, edited by Erv Bales and William Rose, is a collection of papers from a conference on the subject on May 20-21, 1991, in Washington, DC, USA.

  Topics covered in the proceedings include: ideal relative humidity, humidity control strategies, the relationship between humidity and insect infestation, case studies, and more. Though the proceedings concentrate on the home environment, the information in this document should also be of interest to commercial building IAQ professionals who want to become more familiar with the technical details of bugs, mold, and rot. The report ($25) is available from NIBS Publication Department, 1201 L Street NW, Suite 400, Washington, DC 20005, USA; (202) 289-7800.
- The booklet *Measuring Ventilation Using Tracer Gases* describes why, when, and how to measure ventilation rates via tracer gases. The booklet is produced by Brüel & Kjær, which manufactures tracer gas monitors. While this may put into question the objectivity of the booklet's material, the booklet is a sales pitch only in that it promotes the use of tracer gas testing. (No mention of Brüel & Kjær products is in the booklet.) It is substantive, clearly written, and free. For a copy of the booklet, contact Ben Caswell, Marketing Communications Manager, Brüel & Kjær Instruments, Inc., 185 Forest Street, Marlborough, MA 01752, USA; (800) 252-4871, Fax: (508) 485-0519.