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Technology, Research, and News for Indoor Environmental Quality

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Industry Product Testing - Leveling the Playing Field

Building products and materials are now being scrutinized for their impacts on broader environmental considerations as well as indoor air quality (IAQ) and on occupants' comfort and health. These considerations include the local and global atmosphere, energy, and natural resources and systems. How building materials affect occupants is receiving far more attention; this stems from a growing awareness of sick building syndrome and the situations of asthmatic, allergic, and chemically-sensitive building occupants.

The growing interest in the environmental consequences of building design, construction, and operation is variously called sustainable design, green building, and environmentally-responsible design, among other things. The flood of media interest, publications, conferences, and marketing for architects and other building-design professionals reflects the growing awareness. Government and corporate activities point to a shift in design emphasis toward a much greater consideration of the environmental impacts of building design.

In 1981, we coined the term building ecology to describe the inter-relationships of buildings to building occupants and to the broader environment (Progressive Architecture, April 1981). We were particularly interested in the impacts of buildings on their occupants' health – not just air quality, but also lighting, acoustics, and other aspects of indoor environmental quality under the designer's control. Now we find the term building ecology used frequently as part of the new-found interest in environmentally conscious design.

The Importance of Material Selection

Building materials and products are extremely important IAQ determinants when a building is newly constructed, renovated, or furnished. They emit volatile organic chemicals (VOCs) that can be odorous, irritating, or toxic. New building materials can easily contribute many thousand times the VOCs that are emitted by the normal use of the building. On the other hand, once they have aged for several weeks or months, building materials contribute only a small fraction of total VOC emissions: sometimes as little as 1 or 2% of all VOCs and typically around 10 to 30% depending on the emissions from occupant use of the building. Once buildings are occupied, occupant activities and the related office or consumer equipment and products usually dominate the sources of indoor air pollution. Building maintenance and cleaning products can be the greatest source of VOCs depending on their composition and frequency of use.

Building design professionals (architects, engineers, interior designers, landscape architects, and others) exert enormous influence on manufacturers of building products by their material selections and specifications. The cost of specified products and materials for a building is far larger than the professional design fees: typically, it is upwards of 3 to 10 times as large. A 100,000 square foot office building or school, at $100/square foot, costs $10 million to construct with $4 million to $6 million in material costs. In fact, some building design professionals, facility managers, and others

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charged with selecting and specifying such purchases are now leveraging their power to insist on products that contribute to good IAQ and meet other environmental criteria. Manufacturers have responded by evaluating and modifying their products and by marketing them with information on their environmental impacts or the lack thereof.

IAQ is not the only performance issue being addressed; designers and manufacturers alike are considering a whole range of other environmental factors. Table 1 lists a few of the more prominent ones. These factors are important in each phase of a product's life cycle. Major phases of a product's life cycle are the extraction of raw materials, the transport of raw materials and manufactured components, manufacture or assembly, packaging, distribution, acquisition, consumption or use, and disposal or recycle. Among all the categories of environmental concerns, the impacts on IAQ and, thereby, on occupant health and well-being are among the best understood and easiest to predict and evaluate at this time – despite the substantial gaps in our knowledge.

Table 1 - Environmental criteria – categorical impacts of design decisions.

Macro Environment	
	Atmospheric impacts
	Water use/pollution
	Resource depletion: limited vs. renewables
	Biodiversity – habitat loss
Energy	
	Required for construction
	Required for use of facility
	Disposal or re-use
	Energy conservation
Waste	
	Re-use of existing facility, infrastructure
	Recyclability
	Byproduct production
	Waste generation
	Impact on air, water, soil, living things
Health and Welfare	
	Socio-economic impacts
	Byproduct toxicity
	Local socio-economic impacts
	Global socio-economic impacts
	Hazards of production, use, disposal
	Indoor air quality – human health

Efforts to develop criteria and procedures for assessing other impacts of materials through life-cycle analyses (LCAs) are just in their infancy. Some of the more enlightened manufacturers are scrambling to assess their products' environmental impacts and are participating in a number of public and private activities aimed at standardizing such assessments. The Chemical Manufacturers Association has a group looking at risk assessment with an emphasis on VOC emissions testing. Armstrong World Industries has developed and advocated its own approach to life-cycle analysis. The US Environmental Protection Agency, the American Institute of Architects, the American Society for Testing and Materials, and many others all have active projects in this area. (See the list of representative projects and contacts at the end of this article.)

Evaluation Standards

Material specifiers and purchasers need to be able to make meaningful comparisons between products. Without reliable data such as standardized testing results for comparable products, such comparisons are virtually impossible to make. To generate this information, there is a need to develop standard methods for testing and evaluating products.

While some manufacturers have trade associations that have developed standardized emission tests for their products, many remain steadfast in their head-in-the-sand positions. As a consultant to architects and building owners, I've worked with manufacturers in diverse contexts. Many simply do not know what comes out of their products after manufacture or later in the life cycle. It seems obvious that product development should be based on such knowledge.

Developing and using standardized test procedures can help conscientious manufacturers improve their products. By comparing test results to those of competitors products, they can determine, at least, that they are no worse than the norm for the industry. Companies benefit in the long run by eliminating many lawsuits and by providing a strong defense in those that must be pursued. Potential purchasers benefit by reviewing comparable information among products with comparable end uses. IAQ in general improves by a reduced number of products with excessive emissions.

The "ignorance-is-bliss" attitude sustained by many manufacturers is not supported by recent court decisions, particularly in lawsuits regarding manufacturers' liability for asbestos, formaldehyde, certain termiticides, and a long list of other hazardous materials. Courts have ruled that lack of knowledge is not an acceptable defense. Juries are not forgiving of manufacturers' ignorance.

Some industries have adapted existing trade associations or created new ones to help them respond to the need for "environmental" performance information including the development of standardized test protocols. This creates a level playing field where small and large competitors are equals, and where decisions including product selection or legal action are not arbitrary.

The Case of Formaldehyde from Composite-Wood Products.

The increased use of composite-wood building products with formaldehyde-based resins resulted in high formaldehyde concentrations as buildings were tightened up to conserve energy. The earliest reported studies were those of Lars Mølhave and Ib Andersen of Denmark; they reported their studies of formaldehyde emissions from chipboard in the early 1970s. By the late '70s, concern had spread throughout Europe and the United States. Formaldehyde concentrations exceeding one ppm were not uncommon in homes and buildings where these products were abundant either in the structure, in the finishes, or in the furnishings. This was particularly the case in mobilehomes and manufactured housing.

The identification of formaldehyde as a possible human carcinogen in the early 1980s accelerated improved testing, standard tests, and emission limits. Affected individuals filed many lawsuits, often successful, against mobilehome manufacturers as well as the composite-wood products industry itself. Some European governments adopted a maximum air concentration limit of 0.1 ppm formaldehyde based on human irritation responses. These limits were more widely embraced in Europe and North America in the early 1980s.

At that time, the composite wood products industry (particleboard, hardwood and softwood plywood manufacturers) developed a standard test for formaldehyde emissions from their products. Product labeling and the development of low-emitting and even of non-formaldehyde-resin based products followed. The standard test was adopted in the mid-1980s by the US Department of Housing and Urban Development for those products used in manufactured housing and mobilehomes. It later became an ASTM standard test (E1333). It is now under revision, and the new version is likely to incorporate much of what has been learned by indoor air researchers and commercial laboratories from testing VOC emissions from many types of products and in various types of environmental chambers and other testing apparatus.

Over the past two decades, formaldehyde emissions have decreased enormously (generally more than tenfold) due to improved formulations and manufacturing techniques. Standardized test results have stimulated these changes and made their evaluation more reliable. Purchasers have learned that they have choices, and the manufacturers have reacted appropriately. Other product classes such as carpets, adhesives, and paints are currently undergoing similarly significant revolutions in composition and manufacturing processes. Consequently, emissions of toxins and irritants to the building (and the larger) environment are lessening.

The National Particleboard Association has begun a comprehensive program to test VOC emissions from industry products. By identifying the dominant compounds emitted from the products, the manufacturers can learn which components are the most important sources and make changes that will improve performance and marketability and reduce legal liability. The first results indicate that there are significant differences among products and that purchasers can benefit from obtaining test data. Results of the first tests are shown in the following article, Particleboard and MDF Emissions Test Results.

The Case of Carpet

Responding to considerable public and some governmental concern regarding odor, irritation, and possible health effects from VOCs emitted by newly installed carpets, the Carpet and Rug Institute (CRI) developed its own test for measuring certain compounds emitted from its members' products. The test is based on the ASTM Standard D5116-90, Guide for Small Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products. CRI has developed a labeling program for its members' products that pass CRI's standards.

Many of CRI's critics believe that the tests may be misleading because the number and type of each manufacturer's products tested is very small. CRI officials believe the testing program will result in improved carpet products since it has already been able to identify at least some carpet products with emissions that exceed its standards. The test method developed for CRI's program has been revised slightly and is about to go through the balloting process on its way to becoming a standard at ASTM.

Improvements in carpet tile are an impressive example of the positive use of emissions test data. When required to respond to a large customer's concerns about emissions in the mid-1980s, Milliken began evaluating its product. The product was radically changed, and now Milliken's carpet tile is very low-emitting when compared to the rest of the major manufacturers' products. Using a backing made from a combination of polypropylene and polyethylene instead of PVC, Milliken has come up with a carpet tile with very low emissions right from the start. Meanwhile, the other major manufacturers are using a conventional PVC backing that has fairly high VOC emissions by comparison: perhaps ten times as high as Milliken's. And, these emissions generally tend to decay slowly.

In addition, Milliken has for several years offered a low-VOC adhesive for use with its product. Milliken does not emphasize the IAQ advantages of its products in its marketing efforts; unless a potential specifier or purchaser asks for emissions test results, they may never learn of the advantages available. Other low VOC-emitting (solvent-free) carpet adhesives are available throughout the floor-covering industry, although some of the older products are still on the market.

Testing Shows the Differences Can Be Large

Within particular product types, measured emissions of a hazardous or odorous component may be as much as a hundred times greater than those of a competing product. In many cases, certain hazardous substances are simply not present in one product that is functionally equivalent to another that emits the substances. Tests can show the decay rates of emissions so that installation practices, ventilation, and occupancy can be arranged to minimize occupant exposures.

Detailed testing that identifies all chemical substances reveals that different manufacturers' products, ones that appear virtually identical, may actually emit some very different compounds. For instance, testing of nineteen different manufacturers' samples of SBR latex-backed nylon carpet for CRI has shown threefold differences in the emissions of 4-phenylcyclohexene (4-PC), the compound responsible for the distinct "new carpet" odor. And, testing of just two samples of the same type of product for the Consumer Product Safety Commission found some significantly different compounds emitted by each. (Please see ***IAB***, Vol. 2, No. 6, pp. 4-14.) Unpublished recent tests reportedly suggest that some new SBR-latex formulations produce non-detectable 4-PC emissions.

Test Method Development

Testing chemical emissions from different types of products often requires modifying existing test methods. Wet-applied products dry quickly and have high, short-term emissions while solid-sheet materials emit steadily over many months and even years. Caulks and fillers applied in buildings in continuous beads may have initial emission bursts like wet products do, but then continue to emit slowly for months or years. Assemblies such as carpet systems (for example, carpet, cushion, adhesive, underlayment) require special protocols to test their installed performance. These protocols must consider not only the carpet itself but also the pad, adhesive, seaming compounds, floor preparation compounds, and even underlayment or other substrate.

Thin-film wet products like paints and sealants that dry very quickly will produce very high chamber concentrations immediately after installation. This means that several special procedures are needed: to handle the very high moisture content of chamber air, to account for shorter sample collection periods, and to focus efforts on the first few hours and days of product life. More than 95% of their lifetime emissions occur during these initial hours and days. Dry products such as plywood and particleboard have relatively low emissions during the first few hours and days, but their formaldehyde emissions can be measured for months and even years after installation. It may take two years or more to reach the "half-life" for formaldehyde emissions from these products.

Much of the standard guidance currently available is not sufficiently detailed to prescribe exact test procedures for various types of products and materials. Some *ad hoc* test methods have been developed in order to allow manufacturers to provide the required data. However, such test results may not be accepted by all who ask for them. Furthermore, buyers may not be able to compare results of tests conducted by different methods.

Conclusion

We strongly recommend that manufacturers and industry associations form emissions-testing committees to determine whether they need and want to develop a standard test method for their products. They can also determine whether they want to create some type of labeling program so that purchasers can easily compare products. The Danish government has started a labeling program based on the time required for emissions to decay sufficiently that irritation and odor problems will not be likely. They have also worked with industry to find substitute chemicals for toxic ones found in products such as paints. These programs are important examples of effective cooperation between government and industry for the benefit of all.

For more information:

The Environmental Resource Guide is a quarterly publication from the American Institute of Architects including, among other things, material reports containing modified life-cycle analyses of various generic building materials and product types. These are general overviews of environmental issues and do not, in themselves, identify environmentally preferable products. They do suggest the sorts of questions designers and other specifiers and purchasers of building products should be asking of manufacturers. Available from the AIA, (800) 365-ARCH or (202) 626-7300.

ASTM Committee E50 on Environmental Assessment. This group is writing standards for Green Buildings, Pollution Prevention, Life Cycle Analysis, and other environmental design concerns. Contact Rose Tomasello, Staff Manager, ASTM, 1916 Race Street, Philadelphia, PA 19103, (215) 299-5481.

The EPA Indoor Air Clearinghouse is a source for reference documents, information, contacts, and free publications. (800) 438-4318.

The Chemical Manufacturers Association has a project looking at risk assessments related to emissions from indoor sources. Contact Carolyn Leep, Manager, Health Issues, CMA, 2501 M Street, NW, Washington, DC 20037, (202) 887-1100, fax (202) 867-1237.

EPA: Center for Environmental Research Information, Cincinnati, (513) 569-7562.

Emissions Testing

Particleboard and MDF Emissions Test Results

The average TVOC emission rate from unfinished particleboard and medium-density fiberboard (MDF) was 1.35 mg/m^3•hr (excluding formaldehyde) at the end of a five-day small environmental chamber test cycle. Two thirds of the total VOC emissions was acetone and hexanal (46 and 21% respectively). Laminated products' emissions ranged from 0.17 mg/m^3•hr for particleboard with thermofused melamine to 2.11 mg/m^3•hr for particleboard with vinyl.

Mike Hoag of The National Particleboard Association reported these results in a paper prepared for presentation at the 28th International Particleboard/ Composite Materials Symposium held April 12-14 in Pullman, Washington. Formaldehyde emissions tests are conducted and reported routinely, but these results represent the first published survey of particleboard and MDF product VOC emissions in the US. They indicate that these products can be strong sources of VOC emissions, and they demonstrate the value of detailed emissions testing.

Identifying the dominant compounds (acetone and hexanol) allows manufacturers to determine their source. It also allows for evaluating the potential for odor, irritation, or toxic effects from exposure to the products. Finally, it allows potential purchasers to compare test results from specific products or product types and make informed decisions prior to a purchase or specification decision.

As expected, nearly all emissions decreased with increasing exposure time after 24 hours. Very wide ranges of emissions in finished materials exist. According to Hoag, these differences are likely due to differences in the laminating materials or the adhesive systems. In general, VOC concentrations were lower in the finished materials than in the unfinished ones.

Table 2 lists the notations used in subsequent tables and figures for convenience. Table 3 lists the test results for all products. Note that in most cases, two samples of each type of product was tested. (Hoag's paper did not state whether these were from the same or from different manufacturers.) We have calculated the age of the products based on Hoag's report. The report contains chamber concentration data for 19 individual VOCs. We have not reported those data here due to space limitations.

Figure 1 shows calculated TVOC emission factors for each product test at 24 and 120 hours. We have used a log scale to improve the readability of the figure. Note the very large differences even among MDF products. These differences are in both the absolute levels reported and in the decay from 24 hours to 120 hours. This suggests the importance of product selection based on emissions test results.

Figure 2 shows the calculated formaldehyde emission rates for all products. Here again, emissions differ greatly among products and indicate the importance of emissions data in the manufacturing and selection processes. Some products' emissions appear to actually increase from 24 hours to 120 hours. The reader is urged to review the data for formaldehyde emissions in Table 3. Note the very large differences among products of the same type. Also note the lack of consistent decay rate patterns. These results suggest the need for more careful control of the sample specimens before

Table 2 - Notations used for test materials.

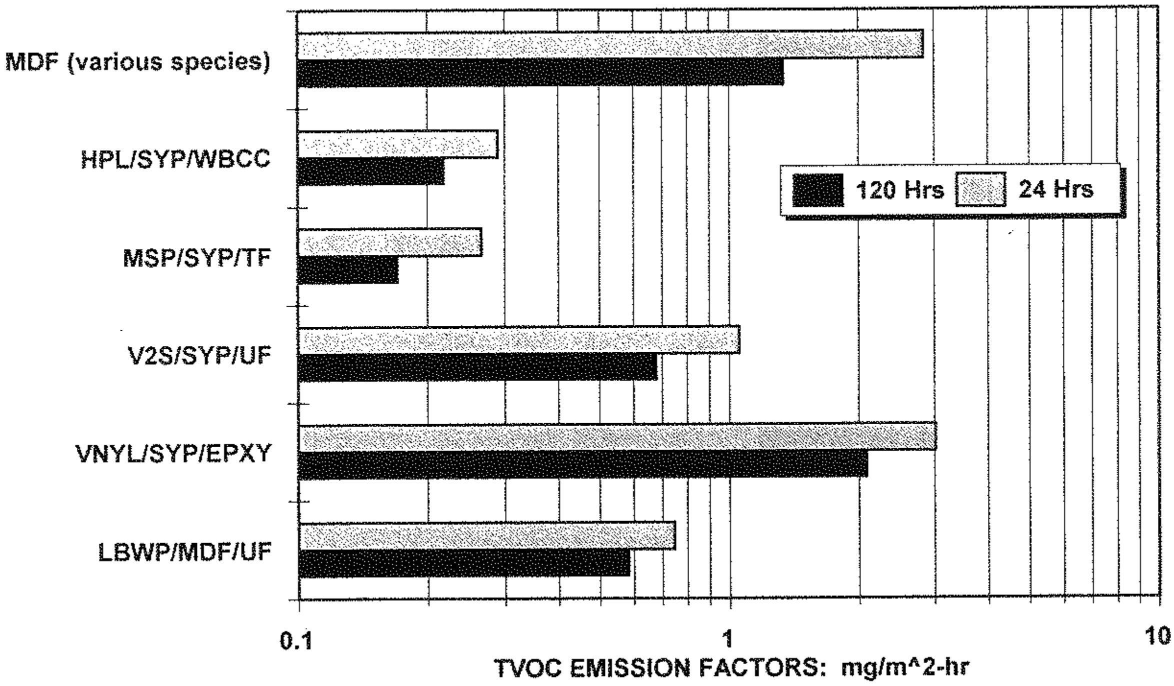
Substrates	
SYP	Southern Yellow Pine
MDF	Medium-density fiberboard
HDWD	Hardwood
WFIR	Western Fir
Overlays	
HPL	High-pressure laminate
MSP	Melamine-saturated paper
V2S	Veneer 2 sides – Oak or Beech/Poplar
VNYL	6 mil vinyl
LBWP	Low-basis weight paper – 30 gram top coat
Adhesives	
WBCC	Water-based contact cement
TF	Thermofused
UF	Urea formaldehyde
EPXY	Epoxy

Table 3 - Chamber air concentrations for various MDF and Particleboard products (after Hoag).

SAMPLE DESCRIPTION	AGE months	FORMALDEHYDE ug/m^3		FORMALDEHYDE ppm		TIVOC* ug/m^3		TVOC ug/m^3		TIVOC/TVOC %	
		24 Hrs	120 Hrs	24 Hrs	120 Hrs	24 Hrs	120 Hrs	24 Hrs	120 Hrs	24 Hrs	120 Hrs
MDF/SYP	3.5	603	421	0.49	0.34	2599	851	2880	918	90.2	92.7
MDF/SYP	7.5	24	123	0.10	0.10	849	647	900	734	94.3	88.1
MDF/WFIR	7.3	99	132	0.08	0.11	171	73	196	88	87.2	83.0
MDF/WFIR	0.7	809	375	0.66	0.30	344	132	414	182	83.1	72.5
MDF/WFIR	8.5	120	95	0.10	0.08	415	266	436	292	95.2	91.1
MDF/HDWD	3.9	246	153	0.20	0.12	1546	1106	1666	1176	92.8	94.0
MDF	8.6	183	175	0.15	0.14	1610	402	1628	442	98.9	91.0
MDF	8	110	129	0.09	0.10	1649	807	1706	816	96.7	98.9
HPL/SYP/WBCC	2.3	116	54	0.09	0.04	114	64	156	87	73.1	73.6
HPL/SYP/WBCC	2.3	127	79	0.10	0.06	82	96	95	102	86.3	94.1
MSP/SYP/TF	3.1	65	62	0.05	0.05	100	48	134	62	74.6	77.4
MSP/SYP/TF	2.5	9	26	0.01	0.02	78	69	96	85	81.3	81.2
V2S/SYP/UF	4.7	364	408	0.30	0.33	443	427	494	472	89.7	90.5
V2S/SYP/UF	2.8	719	371	0.58	0.30	293	85	418	116	70.1	73.3
VNYL/SYP/EPXY	2.9	14	28	0.01	0.02	2451	677	2520	854	97.3	79.3
VNYL/SYP/EPXY	6.5	21	21	0.02	0.02	62	808	87	962	71.3	84.0
LBWP/MDF/UF	2.6	140	153	0.11	0.12	468	350	504	370	92.9	94.6
LBWP/MDF/UF	2.6	246	89	0.20	0.07	121	125	147	140	82.3	89.3

* TIVOC = Total of individual VOC concentrations,

Figure 1 - TVOC emission factors for each product test at 24 and 120 hours.



testing, possibly involving a lengthy conditioning process to achieve reasonably stable conditions. While this will decrease the value of testing at two time points to observe decay, the five-day period appears far too short to obtain data useful for long-term projections.

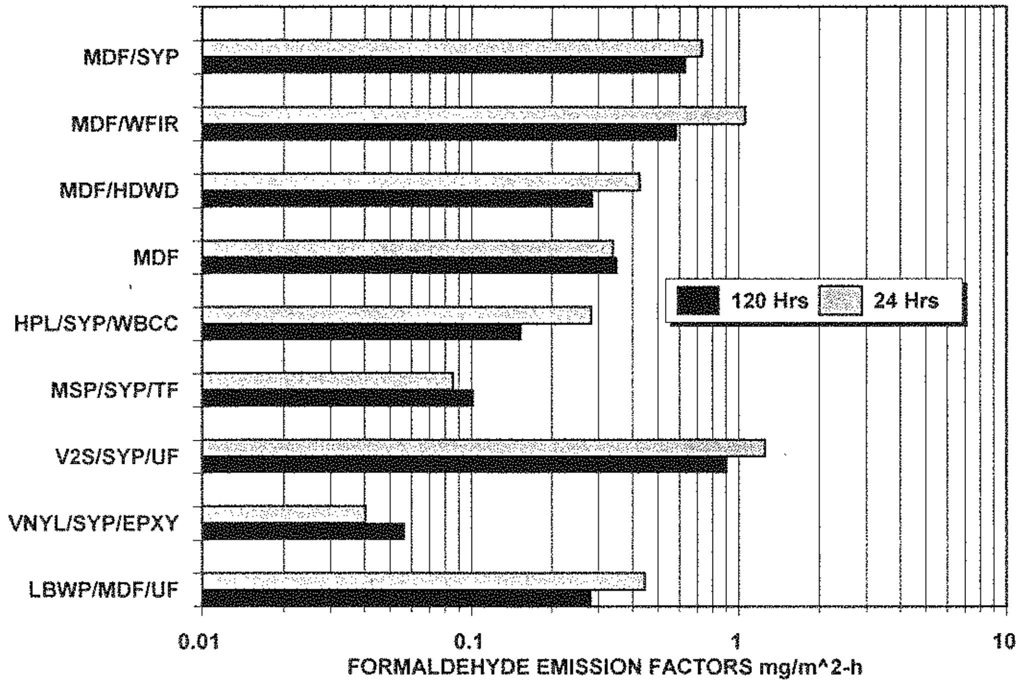
Reference:

Mike Hoag, 1994, "Particleboard and MDF VOC Emissions Testing," presented at the 28th International Particleboard/Composite Materials Symposium, Pullman, Washington, April 12-14, 1994.

Contact:

Mike Hoag, National Particleboard Association, 18928 Premiere Court, Gaithersburg, MD 20879-1569, (301) 670-0604.

Figure 2 - Formaldehyde emission rates for all products.



Symposium Report

Indoor Air and Human Health

Human responses to contaminated air are at the root of all IAQ concerns. Whether we are assessing a problem building, establishing regulations, or designing a new building, ultimately all our actions hinge around our understanding of the impacts of the building environment on occupant health and well being.

A truly remarkable event, the Oak Ridge National Laboratory (ORNL) Life Sciences Symposium, Indoor Air and Human Health Revisited, recently addressed this relationship of indoor air and human health. It was full of provocative concepts and research reports as leading scientists discussed the state of knowledge in their field. The organizers plan a book with the papers from the symposium to be available later this year. The broad range of topics included sensory responses, neurotoxicity, allergy, respiratory illness, bioaerosols, and cancer.

The symposium was impressive for all the knowledge that does exist; however, it was even more evident that there are a multitude of unanswered questions. In summarizing the conference, Ken Sexton of EPA identified some themes he extracted. He called them the three "M"s: markers, mixtures, and multi-factorial. Markers are needed, Sexton said, for chemical classes and biocontaminants, and methods for assessing these are still lacking. The topic of mixtures comes to us often, he said, but little work has been done on indoor air mixtures. Although the problem is obviously immediate and unavoidable in indoor air, we have not really addressed it. The third "M" is the multifactorial character of IAQ problems: the mixtures of issues, if you will.

All we spoke to who attended the symposium thought well of its organization and presentation. The following are short notes from some of the sessions. Hopefully they will whet your appetite for the upcoming book, and we'll advise you as soon as it's available.

Sensory Response and Sensitivity

Bill Cain (Yale University and San Diego) organized this session to relate the neurobiology of the sense of smell to the latest knowledge of likely human responses to chemicals or mixtures. Cain has contributed an enhanced understanding of olfaction and irritation by measuring human responses to chemicals. Also included were discussions of predictive models of irritation and odor based on the structure-activity relationships of chemicals.

Cain prefaced the session by asking the fundamental question, "do odors and irritants cause adverse health effects?" He posed two issues the indoor air community addresses that need illumination from this perspective: 1) How do we solve present problems, and 2) How do we prevent future problems? Cain said that we are fundamentally interested in being able to predict what will happen when people are exposed to indoor air contaminants so we can do something about it if necessary. In his session summary, Cain identified the issues he considers important and said there is a need for standardized protocols for researchers.

Neurobiology of Smell

Charles Greer (Yale University) discussed the neurobiology of the sense of smell. He said the environment affects the life of olfactory receptor cells, the keys to smell. They can be adversely affected by dirty environments. To illustrate, he said that while typically they last about 60 days, they can last 90 days in a clean environment like the Colorado mountains, but they might live only 30 days in a dirty environment like that of New Haven, Connecticut. Thus, the cells change in response to repeated exposure to odorants. Repeated environmental insults can damage receptors resulting in death and, eventually, a lack of regeneration. Thus, there will be a loss in the number of receptors with aging.

According to Greer, the local nervous system circuits take the most important [odor] signal and amplify it – increase the signal-to-noise ratio. He said that the olfactory pathway – the route from the nerves to the brain – offers an optimal conduit for introducing physical, including toxic, substances to the brain. This, we note, has been suggested as the mechanism for several important diseases.

Odor and Irritation

Enrique Cometto-Muñiz discussed findings from the work he has done with Bill Cain on odor and irritation. Studying both anosmics (people who lack a normal sense of smell) and normosmics (people capable of normal odor detection), he presented results from numerous studies of human responses to individual compounds and mixtures. Major factors seem to be the water or lipid solubility of the substances. These characteristics determine their ability to cross the protective barriers and reach the olfactory nerve sites for smell or irritation.

In general, Cometto-Muñiz said, pungency thresholds occur at concentrations about one-third of the saturation vapor pressure of a compound. Odor thresholds tend to be considerably lower – perhaps an order of magnitude or more. Eye irritation tends to occur at concentrations between the two, but closer to nasal pungency, at least for a series of acetates they studied, for example. There are large differences in the odor threshold determinations made by various researchers, but, Cometto-Muñiz said, there is consistency between the Yale group's findings and the meta-analysis done by Devos *et al.* (Please see the references at the end of this article.) And, the more complex the mixture, the higher the degree of additivity they have found with a few studies of limited numbers of chemicals.

Mathematical Models

Michael Abrahams (University College, London) discussed his mathematical modeling to predict nasal pungency and odor threshold. He has developed a model based on critical chemical characteristics such as lipofilicity, hydrogen bonding, and polarity. He said his equation predicts nasal pungency well, but it does not do as good a job for odor thresholds when compared with empirical studies. He has found that at low concentrations, two separate chemicals act independently while at higher concentrations they interact and dissolve less rapidly. He emphasized the time-dependence of irritation sensitivity as an important factor in indoor air exposure assessment.

Electrophysiological Indicators

Gerd Kobal (Univ. of Erlangen, Nuremburg, Germany) discussed his methods of detecting a response by monitoring implanted electrodes that detect changes in electrical potential prior to the subject's awareness of an odor or irritation event. He regards this as a promising technique for obtaining data more rapidly and easily than using many human subjective-response techniques.

Psychological Aspects

Finally, Susan Knasko (Monell Chemical Senses Center, Philadelphia) discussed studies done to evaluate human responses to odors in real-life situations. She said odorants are pumped into air-conditioning systems in Japan for their presumed beneficial effects. She also mentioned the availability in Japan and the US of products labeled as therapeutic based on their odor characteristics. These practices and products, she said, are based on the assumption that pleasant odors have positive effects. However, a study using odorants and placebos showed that people's expectations dominated their response, not the characteristic odors to which they were exposed.

Dr. Knasko said the majority of studies have found no effects of odors on task performance. The exception was a study that found a positive effect of pleasant odors on vigilance (the number of signals detected out of the total presented to a person). While aroma therapists make claims of the beneficial effects of odors, Knasko said there are no studies in the literature that demonstrate such claims are justified.

Respiratory and Allergic Effects

Cecile Rose (National Jewish Center for Immunology & Respiratory Medicine, Denver) chaired the sessions on allergy, sensitivity, and respiratory effects. She started with an overview organized around the different ways of looking at the issues as follows:

- Anatomic sites of interest: nose, sinuses, large airways, small airways, and interstitium.
- Outcomes of interest: disease approach, focuses on diagnoses and treatment rather than cause and effect.
- Types of indoor/occupied spaces and effects on respiratory outcomes.
- Types of exposures: infectious agents, allergens, irritants.

Hospital Environments

Andy Streifel (Univ. of Minnesota) discussed *Aspergilli* and *Legionella* in hospital environments. With spore sizes of 2.5 to 3.0 µm in diameter, *Aspergilli* can easily be airborne and inhaled. Of course, hospitals are high-risk environments because of the increased susceptibility of patients with compromised health status. He described many incidents in which inadequate separation of occupied zones from construction zones resulted in illness, sometimes large scale. Disturbing the environment as much as happens during construction results in considerable increases in airborne microorganisms. In one case, cleaning the tops of fluorescent light fixtures resulted in the release of spores and an outbreak.

Streifel has found many construction-associated disease outbreaks, and, as a result, has developed stringent guidelines he believes are necessary to control the transmission of dust and particles from construction activity into occupied areas of hospitals. The guidelines include construction barriers, but Streifel has not found it easy to obtain compliance. Furthermore, he has identified numerous pathways for micro-organisms to migrate such as leaky window frames. Installing a smoke-evacuation system allows windows to be sealed in hospital rooms – this eliminates an important pathway for bioaerosols. Streifel said anti-fungal treatments are necessary in fireproofing materials used over structural steel components.

Visitors can be sources of biocontaminants, and their activities are not easy to control. Limiting the number of visitors is the only effective measure Streifel described. To control fungal spore concentrations in a sealed room, he suggested that >10 air changes per hour would be required. He suggested that air supply be 10% greater than exhaust, and that point-of-use HEPA filtration be employed. He also recommended monitoring the control equipment performance rather than assuming that it works without verification.

Controlling Tuberculosis Effectively

George Kubica (Dunwoody, Atlanta) discussed tuberculosis control, a growing concern as the number of cases increases and drug resistant strains appear. The TB bacterium is found in a droplet nuclei less than 4 µm in diameter. A cough produces 3500 droplet nuclei and a five-minute talk about 3000. Humans breath about 20 ft^3 of air per hour. The three methods available to minimize the risks of nosocomial infections are ventilation, high-efficiency filtration, and UV-germicidal irradiation. No one method alone is sufficient. The only demonstrably effective means of controlling TB is UV light according to the studies described by Kubica. Ventilation alone is simply not a practical control method. The dangers of UV light to humans can be addressed by placing the light high in the room to protect visitors and hospital personnel: air circulation is controlled so that air is exposed to the UV without unsafely exposing occupants. Ventilation, on the other hand, cannot significantly afford control at practical rates of air movement and exchange, Kubica said.

Individual Variability in Irritation Responsiveness

Dr. Rose also read a brief synopsis of the presentation on variable irritant responsiveness prepared by Rebecca Bascom (Univ. of Maryland) who was unable to attend due to a family illness. According to Rose, Bascom said that inherited characteristics modified by environmental factors are the basis for differential responsiveness among individuals. People sensitive to environmental tobacco smoke (ETS) have far greater [measured] upper-airway resistance and marked inhibition of mucociliary clearance after exposure to ETS compared to non-ETS-sensitive individuals. Techniques such as acoustic rhinometry provide sensitive tools to measure the nasal congestive response to ETS and should help us understand the physiology of the so-called annoyance complaints of SBS.

Ozone and Upper Respiratory Effects

Robert Devlin (EPA's Health Effects Research Lab (HERL)) discussed the effects of air pollutants on the upper airway tract. He described methodologies of interest. Then he said their use shows far more sensitivity to house dust mite exposure for subjects previously exposed to ozone. He said there is a strong correlation between ozone exposure and immediate hospital admissions for asthma. His data suggest that low-level irritant exposures augment allergic responses in susceptible populations, contributing to morbidity associated with poor IAQ.

Fungal Bioaerosols

Harriet Burge (Harvard) said: "Fungi are designed for dispersal in air... Any fungus to which you are exposed is probably capable of causing an allergic reaction. We are only limited by our ability to identify the organisms to which you are exposed. This is the area where we need to do the most work – exposure assessment."

Burge also said that the fungal volatiles (gases released from fungi metabolism) are important as odorants that cause discomfort, as irritants, and as possible carcinogens. We still do not know what causes SBS; there are no data to connect SBS to micro-organisms. But, she said, "I firmly believe we shouldn't live in moldy houses, ever!" She suggested house dust might be used as a surrogate for airborne exposure.

Endotoxins

Don Milton (Harvard) discussed endotoxins, a component of gram-negative bacteria cell walls, starting with words from Lewis Thomas' *Lives of a Cell*: "Endotoxin must feel really awful to a cell because it calls in napalm, bombing, and strafing." He is, of course, referring to the immune system's responses. According to Milton, endotoxins are very potent, and there is a lot of heterogeneity. They directly affect respiratory function, for example, as indicated by the relationship between forced expiratory volume and endotoxin concentration in air. An outbreak of respiratory illness among lifeguards at a public swimming pool was associated with elevated endotoxin levels originating in water features at the pool.

Dust Mites

Thomas Platts-Mills (Univ. of Virginia) described the epidemic of asthma in the US and other countries, citing data of growing asthma incidence on several continents. He said it is hard to prove what's happening, but opined that hay fever is less prevalent than formerly because people don't go outside as much.

He pointed an accusing finger at fitted carpets that can't be cleaned. ("Vacuum cleaning doesn't work," he said, "it just adjusts the dust mites.") Central heating keeps mites warm year-round. Air-tight homes maintain humidity in which mites thrive. According to Platts-Mills, houses are built too tight. He points to federal regulations requiring 10 air changes per hour (ach) for lab rats – otherwise they get pneumonia and die. However, our houses are built to get around 0.2 ach, and that just isn't enough. Finally, cool wash detergents allow us to get our clothes looking clean without using water hot enough to kill dust mites.

An interesting study he cited found that exposure to dust mites at age 2 was a better predictor of current asthma than current exposure for children several years later. He said that both cat and cockroach allergy are very strongly related to asthma. Allergy is an important risk factor for asthma, but exposure to a rhinovirus on top of that will put an allergic child in the hospital emergency room. So, Platts-Mills says, the design of children's bedrooms during early childhood is critical to their health later on. Day-care centers are also important, especially for very young children, and they are generally very poor from an environmental health perspective.

Cat allergen is an issue in offices because it sticks to everything: it's virtually always present because people bring it in with them. In contrast, he said, mite allergen is not a problem because it does not stick to things.

Hypersensitivity Diseases

Dr. Rose also discussed building-related asthma and hypersensitivity pneumonitis (HP). According to Rose, "...HP characterizes a spectrum of granulomatous, interstitial, and alveolar-filling lung diseases resulting from repeated inhalation of, and sensitization to, a wide variety of organic dusts and low-molecular-weight chemical antigens that are often present in indoor environments."

She said that most studies suggest a rather low prevalence of HP, but she suggested it is likely that unrecognized HP is actually quite common based on several factors. The disease resembles others and is often accompanied by normal chest radiography and pulmonary function. False negatives can arise from tests measuring precipitating antibodies, once considered the gold standard for diagnosis. The antigens that cause HP and asthma are abundant where water damage creates favorable growth conditions for microbial contaminants, a common occurrence in modern homes and buildings.

If a diagnosis of HP is made in a single individual in a building, it should be regarded as a sentinel health event because others similarly exposed may be at risk. Results of her investigations indicate that building-related hypersensitivity lung disease is not rare, that attack rates are often high (i.e., near 70%), and that early removal from exposure may not lead to complete resolution of symptoms, physiologic abnormalities, or inflammatory changes in some individuals. She recommends an interdisciplinary approach for the management of building-related hypersensitivity diseases involving physicians, industrial hygienists, building engineers, epidemiologists, and building occupants.

Rose Summary

In her summary, Rose indicated that unraveling the science of building-related respiratory effects will involve understanding the complex interplay between host factors, the nature of the inhalant, and the circumstances of exposure.

For host factors, the work of Devlin identifies ozone-sensitive allergic asthmatics. Bascom describes ETS-sensitive individuals with variability and mucociliary clearance and nasal resistance following low-level irritant exposures. Identifying host factors such as atopy and ETS sensitivity has important implications for understanding the epidemiology of building-related respiratory complaints. Sampling methods such as nasal lavage and measurements of nasal resistance have important applicability as tools to define the inflammatory events in the respiratory tract that lead to building-associated illness.

As pointed out by Burge, Milton, and Platts-Mills, characterization of indoor allergens, irritants, and toxins and the development of better methods for exposure assessment are critical in understanding respiratory health effects from indoor air and will undoubtedly be a major focus of future research. With respect to infectious inhalants in buildings, many questions remain regarding their transmission and control. However, as Streifel points out, we know enough about hospital construction and demolition risks to immuno-compromised patients that we must implement methods to prevent hospitals from becoming unwitting causes of infection-related mortality. Similarly, as pointed out by Platts-Mills, allergen avoidance in homes must become first line therapy in the management of cat and mite dust sensitive asthmatics.

Respiratory infections, irritation, and hypersensitivity diseases are undoubtedly much more widespread than is currently recognized. In some cases, keeping the patient out of the building may not lead to resolution of abnormalities even when illness is recognized quite early. Future research efforts should include multidisciplinary teams of epidemiologists, basic scientists, clinicians, ventilation engineers, and industrial hygienists.

Neurotoxicity

Hugh Tilson (EPA's Health Effects Research Lab) chaired the session on neurotoxicity. He said the symptoms from exposure to VOCs, pesticides, and carbon monoxide in indoor air resemble symptoms of stress.

Vernon Benignus (EPA's Health Effects Research Lab) described research into the effects of chemical irritants on task performance. He described two fundamental mechanisms. One is systemic and affects the central nervous system (CNS). The other is functional and its affects are other than systemic. Describing the problems in research, he focused on the problem of choosing the exposure concentration to study. He pointed out that if the effects of concentrations found in the environment were easy to find, the levels at which they occur would not be permitted in the research context. In order to do the studies at environmental levels, researchers must run large numbers of subjects to get statistically significant effects. It is difficult to actually blind both subjects and researchers to the exposure conditions, although we may partially blind subjects by using several different exposure levels. Exploratory work requires hypothesis testing for confirmation.

He reviewed the work done to date of relevance to indoor air. He pointed out that Mølhave's work reported in 1986 used sensitive subjects and was not double-blind. Otto's efforts to replicate Mølhave's findings (1990) did not use sensitive subjects and could not replicate the results. Kjaergaard *et al.* (1991) repeated the work with sensitive and non-sensitive subjects, and got results on digit-span tests in both groups. Bach *et al.* (1990) exposed non-sensitive subjects to four concentrations of formaldehyde and found a dose-response related decline in digit-span performance. Benignus concludes that there are performance effects from irritant exposure, but that there is only one convincing study, that of Bach *et al.* There is simply too little literature available on the problem at this time.

Since there was so little on indoor air, Benignus said he looked at related literature on the effects of noise and cold on task performance. There he found clear evidence of impacts. However, even this literature, he said, was characterized by insufficient or inconclusive data. One explanation of the effects found is the distraction hypothesis: that noise and cold effects are results of disruptions of task performance. He recommended that tests used to evaluate the impacts of indoor air should use well-standardized tasks known to be sensitive to other conditions.

Conditioning and the Immune Response

Donald T. Lysel (Univ. of North Carolina) presented one of the most provocative papers at the meeting. In his laboratory, researchers place Lewis rats in a chamber for 40 minutes and give them mild electrical shocks five times. Then, twelve days later, they return the rats to the shock chamber without shocking them. This is referred to as exposure to conditioned aversive stimuli.

The results are significant: they include measurable changes in immune system measures such as natural-killer cell formation and the responsiveness of splenic and blood lymphocytes to T- and B-cell mitogens. Lysel says these results clearly demonstrate that learning processes can be involved in the neural and endocrine responses to environmental stimuli and these responses can induce pronounced alterations of immune status.

Lysel described a variety of mechanisms that can produce the observed changes including CNS signals to the immune system via the hypothalamic-pituitary-adrenal axis and nerve fiber connections with cells of the immune system.

We believe Lysel's findings are significant for cases such as building occupant exposure to a transient indoor air pollution exposure event. Such exposure may result in decreased immune system performance during subsequent, similar, or new exposures.

Mechanisms of Immune System Stress

Bruce Rabin (Univ. of Pittsburgh) described the way the brain translates a perceived stress into an immune system response. The immune system constantly surveys the body to identify things that should not be there. When it sees something, it signals the brain by sending cytokines. Odor, especially irritating odors, overlap with the immune system in this respect. When the brain learns from the immune system that something is going on that should not, it signals the endocrine system through the sympathetic nervous system and the hypothalamus to stop reproduction – such as leukemia – by down-regulation. Thus, stressful situations down-regulate the immune system.

Why do rheumatoid arthritis, colitis, and other diseases arise at times of stress? Down regulation from stress accompanied by pre-dispositions to immunologically mediated disease, says Rabin. When we attempt to perform a frustrating task, there are changes in cardiovascular and neuroendocrine responses. In acute stress, CD-8 cells increase. In chronic stress situations, CD-8 cells decrease. This is important. In auto-immune diseases such as hepatitis, the immune system eliminates the virus. If the immune system fails to get rid of the hepatitis virus, chronic disease occurs.

There are big differences between acute and chronic stress in terms of immune system functioning as determined by CD-8 production. There are big differences in natural killer cell production as well. Childhood abuse, for example, is a clear predictor of lower production of natural killer cells. And cerebral dominance is a predictor of immune system function; it is known that left-handed people die earlier than right-handers.

Studies with monkey communities show that having a buddy buffers against the effects of stress on immuno-suppression. This is also well established in humans, Rabin said. Finally, moderate exercisers habituate to the voluntary stress of physical exertion and don't respond to stress by immuno-suppression as much as do non-exercisers. Meanwhile, high performance athletes don't get the protection against disease obtained by moderate exercisers.

References:

M. Devos *et al.*, *Standardized Human Olfactory Thresholds*, New York: Oxford University Press, 1990.

IAQ News

ISIAQ Election Results

Thomas Lindvall, founding and outgoing president of The International Society of Indoor Air Quality and Climate (ISIAQ), has announced the results of the society's first open election for officers. The new president, beginning September 1, 1994, is Professor Olli Seppänen of Helsinki University. Three vice presidents were elected, including for Policy, Susan Rose (USA), for Practice, Gaute Flatheim (Norway), and for Research, Marco Maroni, (Italy). All three were incumbents having been originally selected by the organizers of ISIAQ. Professor Ken-ichi Kimura (Japan) is the new treasurer and Douglas Walkinshaw (Canada) was elected secretary.

Fifty-three percent of the members/founders cast votes. Some founders are not members but were permitted to vote. All five candidates won by a substantial margin, and only in one race did the runner-up receive more than a fourth of the votes. Each of the five elected officers was the ISIAQ Nominating Committee recommendation for the office. These and the other 14 candidates were nominated by mail and agreed to accept the nomination. The detailed vote count appears below.

ISIAQ was founded in 1992 and is an independent, open membership organization for professionals, researchers, and policy makers in the indoor air and climate field. Members have started two task forces to address issues of moisture control in buildings and investigations of problems buildings. ISIAQ is a sponsor of many conferences such as Healthy Buildings '94 in Budapest (August 22-26, 1994), Healthy Buildings '95 in Milano (September 11-14, 1995), Indoor Air '96 in Nagoya (July 21-26, 1996), and other conferences planned for Australia and Norway.

The $100/year membership dues ($60 for students) covers a subscription to the journal, *Indoor Air*, now in its fourth year of publication. *Indoor Air* is edited by David Grimsrud and is published by Munksgaard of Copenhagen, Denmark. Members also receive a $35 discount off the regular prices of ***BULLETIN*** subscriptions. Multi-year subscribers paid in advance receive bonuses. While the society has no paid professional staff, Dr. Walkinshaw has performed the functions of its executive officer on a voluntary basis since the founding of the organization. Readers who wish to join or obtain more information should contact ISIAQ at PO Box 22038, Sub 32, Ottawa, Ontario, Canada K1V 0W2, fax (613) 731-2559.

ISIAQ Election Vote Count

The following is a detailed accounting of the votes for the five elected offices, as reported by the Election Committee, Ole Fanger, Thomas Lindvall, and James E. Woods, Jr.

President
- Olli Seppänen, Finland 241
- Charlene Bayer, USA 6
- Abstain 2

Vice President, Policy
- Susan Rose, USA 194
- Philomena Bluyssen, The Netherlands 42
- Abstain 13

Vice President, Practice
- Gaute Flatheim, Norway 152
- Charlene Bayer, USA 9
- Hal Levin, USA 64
- Francis Offerman, USA 8
- Robert Olcrest, USA 4
- Richard Shaugnessy, USA 7
- Abstain 5

Vice President, Research
- Marco Maroni, Italy 137
- Charlene Bayer, USA 13
- Giuliano Cammarata, Italy 3
- Koichi Ideda, Japan 11
- Jouni Jakkola, Finland 11
- Pennti Kalliokoski, Finland 6
- Lars Mølhave, Denmark 42
- Peder Wolkoff, Denmark 19
- Abstain 7

Treasurer
- Ken-ichi Kimura, Japan 212
- Charlene Bayer, USA 21
- Abstain 16

Secretary
- Douglas Walkinshaw, Canada 207
- Francis Gallo, USA 14
- Brian Krafthefer, USA 22
- Abstain 6

Publications

Indoor Air '93 Summary Report – Get This Book!

What an awesome task! What a magnificent job! Olli Seppänen, President of Indoor Air '93, and other conference organizing committee members have compiled the *Indoor Air '93 Summary Report*. This may establish another precedent that future conference organizers will want to follow: the creation of a single, readable volume summarizing the giant triennial meeting.

Like all the conferences before it in the triennial series, Indoor Air '93 was large, well-attended, and full of hundreds of papers representing the broad range of issues concerning the international indoor air community. No one who attended could possibly absorb even a large fraction of the many outstanding papers, posters, and workshops – the six volumes of the *Proceedings* are daunting. However, Professor Seppänen and his collaborators have digested the valuable information from the *Proceedings* to create the summary report. It is a very handy companion to the *Proceedings* and a valuable resource by itself, even if one does not own a copy of the *Proceedings*.

The report contains a 32-page executive summary prepared by Professor Seppänen. The Finnish conference organizers have written summaries of the 29 conference sessions. There is an annotated bibliography of the 690 papers presented at the conference, and a complete listing, keyword index, and author index.

Professor Seppänen's executive summary is a clear overview of the current state of knowledge in indoor air. We found his views on ventilation and thermal control especially interesting because, writing in the area of his own expertise, he offers more observations and analysis than in some of the other portions of the summary. His summary comprises one of the most succinct, comprehensive overviews of indoor air issues available anywhere.

Each of the 12 authors of the conference session summaries is a Finnish indoor air expert with substantial command of the subject matter addressed in the one to four sessions they describe. The reviews are annotated with references to the conference papers from both oral and poster sessions. While not every paper is mentioned specifically, most are included in some sort of general remarks. The session summaries are typically six to ten pages, making them quite readable while not being excessively detailed. We recommend reading the summary with a copy of the relevant *Proceedings* volume handy to look up data in papers of particularly interest.

The cost of the report including postage by air mail is 300 Finnish Marks. At this writing, that is about US $54. Copies are available from the Finnish Society of Indoor Air Quality and Climate - FiSIAQ, P.O. Box 87, FIN-02151, Espoo, Finland, fax 358 0 451 3611.

Publications

Assessing Ventilation in Commercial Buildings

Andy Persily has done it again: another excellent technical publication from the NIST scientist. This one includes just about everything you might want to know about assessing ventilation in mechanically ventilated commercial buildings. It's 123 pages long and describes specific procedures that can be applied in the field. Persily has done lots of assessment himself, and he has written a useful, clear, well-illustrated manual for professionals concerned with building HVAC system performance.

Persily's goal was to provide enough information for a reliable preliminary assessment. He says the outcome may be that there is a need for a more detailed, complete system evaluation. The intended audience is the typical IAQ professional who lacks a mechanical engineering background or experience. All in all, we think many of our readers will find this a very useful, straightforward publication.

To obtain a copy (while they last), contact Andrew J. Persily, NIST, Bldg. 226 Room A313, Gaithersburg, MD 20899, (301) 975-6418, fax (301) 990-4192.

Reference:

Andrew K. Persily, Manual for Ventilation Assessment in Mechanically Ventilated Commercial Buildings (NISTIR 5329). Gaithersburg: National Institute of Standards and Technology.

Publications

Moldy Houses: Clean-up Procedures from Canada

"Why is mold a problem?" Starting with this question, a new booklet provides detailed advice on cleaning up mold from every conceivable type of surface. While intended for the residential environment, the advice is applicable elsewhere as well. The 32-page publication from the Canada Mortgage and Housing Corporation (CMHC) begins by stating in bold print: PEOPLE SHOULD NOT LIVE IN MOLDY HOUSES! It gives reasons why and discusses how to identify mold and distinguish it from dirt. Then it goes into more than 20 pages of instructions on how to decontaminate and clean.

Copies in English or French are available from CMHC, 700 Montreal Road, Ottawa, Ontario K1A 0P7, (613) 748-2000.

In Memorium

Jerome J. Wesolowski
May 11, 1932 – January 1, 1994

On January 1, 1994, Dr. Jerome J. Wesolowski passed away after a brief battle with lung cancer. Jerry had a distinguished career in the public health field and, during the last fifteen years, was active in the indoor air community. He served on numerous state, national, and international bodies, and oversaw the establishment and operation of the indoor air program at the California Department of Health Services, the first statewide IAQ program in the US. He was a keen student of the literature in the indoor air field, and he frequently stimulated important professional work, research, and dialogue.

Jerry received a Ph.D. in nuclear physics from Washington University in St. Louis, MO, in 1963. During his early years of research on nuclear reactions and fission physics, he used neutron activation and x-ray fluorescence to analyze trace elements in ambient aerosols and begin his career path in environmental science. He was one of the original principal investigators of the lunar materials obtained by the Apollo 11, 12, and 13 mission astronauts. As a co-principal investigator in California's Aerosol Characterization Experiment, he collaborated with numerous other distinguished scientists in a pioneering study of smog aerosols.

At the time of his death, Jerry had served for 21 years as Chief of the Air and Industrial Hygiene Laboratory of the California Department of Health Services. At the Department of Health Services, he founded the California Childhood Lead Program, the California Human Monitoring Program, and the California Indoor Air Quality Program. He achieved international recognition for his work on exposures to lead and IAQ including passive smoking. He authored or co-authored over 200 scientific research papers contributing to the development of a better understanding of human exposures to environmental pollutants.

His public service included membership on the EPA's Science Advisory Board Committee on Indoor Air Quality and Total Human Exposure and on the Clean Air Science Advisory Committee. On the former, he helped review EPA's report on Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders, the report establishing the basis for EPA's identification of ETS as a carcinogen. He served on the National Research Council's Committee on Advances Assessing Human Exposures to Airborne Pollutants which prepared the report *Human Exposure Assessment for Airborne Pollutants: Advances and Opportunities.*

In recent years, Jerry was active in founding and directing the US Committee on Poland's Environment (COPE), a non-profit organization established to foster better understanding of Poland's environmental problems and their solutions. Among Jerry's many COPE initiatives were: co-sponsorship of the conference Voluntary and Involuntary Smoking in Central and Eastern Europe, in Warsaw; co-sponsorship of a scientific symposium in Pultusk, Poland, on "Protecting Workers, the Environment and Health in a Market Economy: Translating Science into Policy and Action"; a research study on the "Relationships Between Residential Indoor Pollution and Housing Characteristics" in Krakow; and, sponsorship of numerous Polish scientists and specialists to participate in training programs, exchanges, and conferences in the US and Europe. In recognition of his many contributions to Poland's efforts to solve its many environmental health problems, the Polish Society of Hygiene, established in 1857, awarded Jerry Honorary Membership.

Jerry was a founding member and director of the International Society of Exposure Analysis (ISEA). In the Society, and in many of his other activities, he brought a constant challenge that researchers clearly identify their hypotheses and that work be of high scientific quality. In his honor, the Society has established the Jerome J. Wesolowski Award for sustained and outstanding contributions to the knowledge and practice of human exposure assessment. The first award will be made at the 1994 Joint Conference of the ISEA and the International Society of Environmental Epidemiology (ISEE) in Research Triangle Park, NC, September 18-21, 1994.

Jerry was deeply committed to raising consciousness about the health effects of smoking – both on the large population of smokers in eastern Europe and on passive smokers worldwide. He warned attendees at the Warsaw conference that they should carefully consider the source of funding for much tobacco-smoking-related research and know the allegiances of those who reported on such research.

For those of us who knew Jerry, his loss is a deep and heartfelt one. I was personally privileged to enjoy his company on numerous occasions: to be treated to his incredibly quick wit and to observe his personal concern and his deep social commitment. He strongly believed that in the public health field, you should "Always do the right thing; it will gratify some... and confound the rest!"

Note: Major portions of this article were based on an article by Dr. Joan Daisey for publication in the *Journal of Exposure Analysis and Environmental Epidemiology.* We are grateful to Dr. Daisey for her assistance.

Calendar of IAQ Events

June 18-24, 1994. **Air & Waste Management Association 87th Annual Meeting & Exhibition**, Cincinnati Convention Center, Ohio. Contact: A&WMA, (412) 232-3444, fax (412) 232-3450.

June 25-29, 1994. **ASHRAE Annual Meeting**, Orlando, FL. Contact: ASHRAE Meetings Dept., 1701 Tullie Circle NE, Atlanta, GA 30329, (404) 636-8400.

September 18-21, 1994. **International Society for Exposure Assessment (ISEA) and International Society for Environmental Epidemiology (ISEE) Annual Meeting**, Sheraton Imperial Hotel, Research Triangle Park, North Carolina. Contact: Dr. Si Duk Lee, EPA, Research Triangle Park, NC 27711, (919) 541-4477.

September 25-28, 1994. **Symposium: Emissions from Indoor Sources**, sponsored by ASTM Subcommittee D22.05 on Indoor Air. Radisson Park Hotel, Washington, DC. Contact: Symposium Chairman Bruce Tichenor, EPA/AEERL, Research Triangle Park, NC 27711, 919 541-2991, fax 919 541-2157. or ASTM Symposium Coordinator Dorothy Savini, 1916 Race Street, Philadelphia, PA 19103, (215) 299-5400.

October 17-20, 1994. **ASTM D22.05 on Indoor Air**, Phoenix, Arizona. Contact: George Luciw, ASTM, 1916 Race Street, Philadelphia, PA 19103, (215) 299-5571.

October 30 - November 3, 1994. **IAQ '94**, St. Louis, MO. Contact: ASHRAE Meetings Dept., 1701 Tullie Circle NE, Atlanta, GA 30329, (404) 636-8400.

International Events

June 3, 1994. **Indoor Air Quality and Respiratory Disease**, Hotel Philippe le Bon, Dijon, France. Sponsored by Indoor Air International under the auspices of Institut de Recherches Medicales de Bourgogne. Contact Professor Guy Crepat, Biologie Appliquee, IUT, B.P. 510, 21014 Dijon, France. *Conference fee is 1000 French francs.*

August 22-25, 1994, **Healthy Buildings '94**, Sponsored by CIB, ISIAQ, and HAS, and co-sponsored by the World Health Organization, ASHRAE, and other international organizations. Budapest, Hungary. Contact: Professor Lászl6 Bánhidi, Healthy Buildings '94, Technical University of Budapest, H 1521 Budapest, Pf. 91, Hungary, 361-1812-960, fax 361-1666-808. *The official language will be English. Discounted advance registration fee is $450, $150 for students.*

September 5-9, 1994. **Ventilation '94, The Fourth International Symposium on Ventilation for Contaminant Control**, Stockholm, Sweden, sponsored by Swedish National Institute of Occupational Health. Contact Ventilation '94, National Institute of Occupational Health, S-71 84 Solna, Sweden, +46-8-730-9448, fax +46-8-275-307.

October 5-7, 1994. **Indoor Air Pollution**, sponsored by Indoor Air International, Ulm University, Ulm Germany. Contact: Dr. Lothar Weber, Institute of Occupational and Social Medicine, University of Ulm, Albert-Einstein-Allee 11, 89081 Ulm, Germany, +49-731-502-3395, fax +49-731-502-3415. *The announcement says the official conference language is "English or other translated languages."*

October 6-8, 1994. **Healthy Indoor Air '94**, Anacapri, Italy. [Sponsoring group not identified.] Contact Organizing Secretariat, "Healthy Indoor Air '94," Piazza del Castello, 26, 20121 Milan, Italy, +39-2-72-00-45-36, fax +39-2-80-52-151. *Registration fee is 500,000 Lira 600,000 until June 30 and 650,000 after June 30.*

October 23-28, 1994. **Clean Air '94**, 12th International Conference, Perth, Western Australia, sponsored by The Clean Air Society of Australia and New Zealand Inc. Contact: Promaco Conventions Pty Ltd., ACN 008 784 585, Unit 9A, Canning Bridge Commercial Centre, 890-892 Canning Highway, Applecross, Western Australia 6153, 61-9-364-8311, fax 61-9-316-1453.

November 27 - December 1, 1994. **Indoor Air: An Integrated Approach**, Gold Coast, Queensland, Australia, sponsored by Australian and international organizations. Contact: Indoor Air - An Integrated Approach, PO Box 1280, Milton Qld, 4064 Australia, 07 369 0477, fax +617 369 1512.

February 6-8, 1995. **The 1st International Congress on Intelligent Buildings**, Tel Aviv, Israel. Contact: Secretariat, c/o Stier Group Ltd., 28 Hayezira St., Ramat-Gan 52521 Israel, ++972 3 7516422, fax ++972 3 7516635. *Proposals for papers and workshops are invited. The official language of the Congress is English.*

May 10-12, 1995. **Indoor Air Quality, Ventilation and Energy Conservation in Buildings**, 2nd International Conference, Montreal, Canada, Organized by Centre for Building Studies, Concordia University. Contact: Fariborz Haghighat, Centre for Building Studies, Concordia University, 1455 de Maisonneuve Blvd. W., Montreal, Quebec, H3G 1M8, Canada, 514 848-3200, fax 514 848-7965.

September 11-14, 1995. **Healthy Buildings '95**, Milan, Italy. Contact: Prof. Marco Maroni, ICPS, fax +39 331 568 023.

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