Indoor Air BULLETIN™ Hal Levin, Editor

Technology, Research, and News for Indoor Environmental Quality

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Indoor Air '96 Highlights

The international indoor air community gathers every three years to define the state-of-the-art. The seventh such gathering occurred in July with Indoor Air '96 at Nagoya, Japan. There, 857 scientists and professionals from 51 countries presented and heard papers, viewed posters, attended workshops, met colleagues, and defined the state of the field. The 3,857-page *Proceedings* include some 627 papers. (Copies can be purchased from the organizers; contact, order, and price information is available at the end of this article.)

The general sense we got from Indoor Air '96 was of a maturing and expanding IAQ field that is still defining itself and seeking a cohesive identity. The diversity of professions and disciplines involved was staggering — architects, engineers, microbiologists, industrial hygienists, analytical chemists, psychologists, medical doctors, epidemiologists, physicists, and others. Represented fields included public health, energy conservation, building design and construction, building investigation, research, commercial laboratories, and many more.

The conference was well organized and run by the Japanese hosts led by Professor Susumu Yoshizawa, Professor Ken-ichi Kimura, and Koichi Ikeda. Many others contributed to the success of the conference which will be remembered, among other things, for being the first in the Far East and also for the hospitality and support provided by the organizers to the international guests. Among the many memorable moments was the theme music at the opening and closing sessions composed and performed by Professor Kimura's daughter, Mari, an accomplished musician and composer. Professor Kimura, an architect, beamed with pride, and deservedly so.

We asked several participants from various countries to share their thoughts on the most important or valuable papers or ideas they encountered at the conference. Following are responses from several of them along with some of our own observations. Numbers in parentheses are the *Proceedings of Indoor Air '96* volume number followed by the first page number of the referenced paper.

Geo Clausen

Geo is at the Laboratory of Indoor Environment and Energy, Technical University of Denmark. His comments were lightly edited by the ***BULLETIN****.*

Naturally, it is difficult to digest a conference with so many parallel sessions and kilos of proceedings. Therefore the highlights that I will mention in the following are my very personal, overall impression, rather than a minute analysis of all papers presented.

A major difference between this 7th International Conference on Indoor Air Quality and Climate and previous Indoor Air conferences is that most of the mystery surrounding Sick Building Syndrome has vanished. No one searches anymore for the one magical chemical or environmental parameter that explains all cases of complaints over the indoor environment. Instead, the simultaneous influence of numerous parameters is acknowledged by most researchers. This is a trend that has been developing over the years, but it was quite pronounced at Indoor Air '96. Furthermore,

Inside This Issue:

the days of the very large exploratory field investigations with dozens and dozens of parameters measured without a clear hypothesis of what to find seem to be over. Instead, the results of some intervention studies, which are much better in documenting the effect of one or more selected parameters, were presented.

A number of more specific topics call for some attention:

Perceived Air Quality

Acknowledged by most researchers as an important measure, there seems to be a need for further development of the objectives and methodology. What are the attributes of the perception that we are interested in, and how do we measure these attributes in a reliable way?

HVAC-Components as Pollution Sources

After numerous field investigations have indicated problems with some existing HVAC-systems, comprehensive laboratory investigations are now contributing to a more precise identification of the troublesome components and to ways of solving the problems *e.g.*, by improved maintenance and cleaning.

"Perceived air quality: ...there seems to be a need for further development of the objectives and methodology. What are the attributes of perception that we are interested in and how do we measure these attributes in a reliable way?"
Geo Clausen

Microbiological Contamination

This is still a topic of great interest. It seems that we know how to avoid most problems with microbiological contamination with a few rather simple rules, but field studies continue to reveal horrifying examples of severe microbial growth in both new and older buildings.

Emissions from Building Products

Several comprehensive research programmes on the topic of emissions from building products and their dependence on environmental parameters now seem to provide a major step forward in our wish to understand the mechanisms controlling the emission — an understanding that eventually will lead to better prediction models for prediction of indoor air quality in spaces before the space is built.

Lars Gunnarsen

Lars is at the Danish Building Research Institute and is stationed at the University of the Philippines, Diliman. His comments were lightly edited by the ***BULLETIN.***

Indoor Climate Research and Development

People working on indoor climate have two advantages over most other researchers: We can discuss indoor climate with anyone who breathes the air inside buildings and our research findings are adopted and put into practice almost faster than they are published. This is very motivating for me. It is nice not to be confined to interrelating only with the scientific community. Actually you can talk about indoor climate with almost everybody and you can often learn from these talks. Few other scientists have this tremendous advantage of working on so popular a topic.

Formaldehyde, radon, and asbestos are serious or even man-killing pollutants indoors. Before the research on the problems associated with these pollutants was fully concluded it was my perception that appropriate measures were adopted in most places to keep these pollutants away from people. The need for urgent research on the effects of these pollutants has therefore lessened, and the work is now centered on the monitoring of concentrations and on the polishing of alleviating measures.

The Danish Indoor Climate Labeling is an example of an activity directed at benefiting from this immediate response from construction companies, legislators and the makers of construction products. Nobody can afford to deliberately provide an indoor climate of reduced quality. The cost-benefit analysis does simply not allow this. If the research results are obtained in direct collaboration with the manufacturers of construction products, then these can act even on preliminary results and they do not need to run the risk of marketing faulty materials.

For a real "hard core" researcher this situation has some disadvantages. You may be left with a feeling that nothing scientific was achieved, that the research problems were never solved. It is my opinion that much knowledge was gained during the days of intensive formaldehyde research. Is this knowledge transferred to those doing the "modern" emissions research?

Indoor Climate Research in Developing Countries

At Indoor Air '96 I had expected to witness presentations on indoor climate that would be of immediate value to developing countries. I was disappointed. I

saw instead, presentations of the transfer of knowledge out of the developing countries.

Monitoring pollution levels beside open furnaces and showing pictures of smoke in cottages may motivate donors to finance research, but it does not in any way affect solutions to the very real and life-threatening problems. Knowledge superimposed is often not knowledge successfully transferred, whereas knowledge ingested through experience in the place where it is to be utilized is often sustainable. Research in developing countries must focus on applied, participative research. In this belief, I have worked for the last two years together with Arturo Santos at the University of the Philippines, Diliman, Metro Manila. Our presentations (1:689-694, 1:381-386) are examples of relevant problem-solving research necessary to affect improvements in the bad quality of indoor climate found in many poor countries.

Voting on Scales or Using Trade-Offs

The quality of an indoor climate has traditionally been judged through the use of questionnaires and panels. Important relations have emerged from this. The difficulties in the interpretation of these results are now more and more brought into focus. You may ask an employee if her indoor climate is acceptable. She may vote "clearly not acceptable" and still one would not expect that sentiment to cause her to stay home the next day or to quit her job. The implications and semantics of being dissatisfied or finding something not acceptable can not easily be solved. We try to interpret the results based on voting semantics strictly according to logic but when doing so Fanger's results (1:1053-1058) require higher ventilation rates than the makers of building codes are willing to accept at the moment.

The use of realistic productivity measures seems to be the only way of providing valid input to cost-benefit analyses but productivity is not easy to measure and the successful simplified measures do not necessarily directly match the relevant productivity in a building.

David Wyon from Johnson Controls Inc., USA, Nigel Oseland from Building Research Establishment, UK and I discussed the use of trade-offs. I think that the use of trade-offs or the use of one parameter to quantify annoyance from another is a very promising measuring method for future research. An air conditioning unit may be noisy and it is supposed to cool the air. How noisy can it be before people are willing to forego the cool air in order to stop the noise? In this real-life situation the cost of cool air may be noise and surely air conditioner manufacturers will be extremely interested in the relation of preferred temperature to noise. The number of relevant ties between indoor climate parameters are numerous. Draft/temperature, window area/temperature, noise/air quality, ceiling height/floor area are all examples of relations of great interest and the list may still be expanded. Quantification of annoyance from one parameter may be expressed by another well known parameter just to avoid the problems with the interpretation of scale votes. Using one parameter to express the influence of the other would get us beyond many problems with scale vote interpretation. I can hardly wait to see results from this type of research!

Using Trained Panels

A very refined, almost decadent way of using scale votes is the use of trained panels for the assessment of air quality. Until the conference I was not aware of the discussions in the ***BULLETIN*** based on the article by Philomena Bluyssen and P. A. Elkhuisen also submitted to IA '96 (1:1053-1058). I feel intimate with the subject and would like to give my contribution. Philo and I wrote a joint paper published at Healthy Buildings '94 (*Proc. of Healthy Buildings '94*, Technical University of Budapest, V. 2 pp. 533-538) partly in order to give a common ground for the panel assessments during the European Audit Project. The paper was then apparently rewritten without my input and some more information was added based on the comprehensive new data gathered during the project.

The new article states that an untrained panel of 280 persons is required to match the precision of a far smaller trained panel. This very high number of untrained members of a panel should have caused the authors to stop and reconsider. Data has been successfully gathered and published from untrained panels of far smaller sizes for decades and I suggest that 280 people is far too high a figure.

In the next issue of the Indoor Air BULLETIN:

- ***ASHRAE 62-1989R Public Review Draft***
- ***More Indoor Air '96 Highlights***
- ***TVOC: Is It Dead?***
- ***And MORE!***

There may be a mistake in the calculations caused by a fact also identified by Fanger and collaborators. An unwanted effect of the training is that panelists become less "bold" after training. Their responses become notable for their conservative tenor. They vote high pollution levels too low and low pollution levels too high. This obviously reduces the standard deviation but also changes the dose/response curve to a less steep curve. When the authors made their estimates, they based the estimate of uncertainty on percent dissatisfied on the small achieved standard deviation of decipol votes but not on the achieved relation between voted decipol and percent dissatisfied. They used small standard deviations in conjunction with the steeper relation from the definition of decipol. This results in the accuracy of the trained panel being highly overestimated.

When moving from naive untrained panels to trained panels we run the risk of losing credibility. What is actually changed in the panelists' perceptions during training? Would another panel perform similarly after the same training? What is the trained panel's dose response curve? It may be justified to train and provide the required documentation for very complicated or comprehensive testing. I do not believe the start up expenditures are usually justified. Untrained panels are easy to use, their precision quite predictable, and a panel of 20-40 people usually can provide significant results for most relevant research investigations.

The First Sniff as a Measure of Air Quality

The first sniff acceptability voted either by an untrained panel or a trained panel is a most sensitive measure. It was a serious set back for this technique when the comprehensive measurements with panels in the European Audit Project (4: 237-242) did not find any significant correlation between perceptions by building occupants and assessments by first sniff panels (as reported by Groes *et al.*). This was probably due to the normal adaptation among the occupants and the many other factors influencing their perception of air quality. First sniff is, however, still very important for visitors. First impressions will last for a long time. All of us have entered shops and restaurants which became unacceptable to us because our noses detected a foul odor on the first sniff. It remains our most sensitive measure of air quality.

Moving from the Stationary to the Transient

In spite of the fact that our environment seems ready to adopt even our preliminary results, we are still waiting for some major breakthroughs in many areas. Presentations at the conference were centered on big, conservative projects wherein efforts were directed at consolidating knowledge for stationary environments, whereas the answers to many of our indoor climate problems remain fixed in the transient events we have in our buildings.

The repainting of a fraction of a wall or applying floor wax results in very high air concentrations of these chemicals for some hours. Direct sunlight hitting an inner surface causes a sudden rise in temperature. Ventilation rates, air humidity, and the concentration of many pollutants is suddenly changed during the normal daily start and stop of air conditioning. These transient events probably still affect air quality long after the time everything else has stabilized. Sorption, evaporation controlled emission rates, moisture changes and so on — we need more research to show the magnitude of these effects!

Total Materials Input to Buildings

Why do emission chamber measurements show that emissions decay fast? Some tests show emission rates below detection after some hours and the best analyzers are able to quantify during the first weeks. My perception is that emissions reduce the air quality over several years. Part of the explanation to lasting reduced air quality may be found in those compounds introduced frequently such as cleaning agents and floor wax. Another part of the explanation may be found in the heavy construction products such as concrete and gypsum. They act as effective absorbents with a huge capacity for soaking up high levels of pollution introduced into the buildings through new products. Later these sponges re-emit what they have absorbed at a slow and continuous rate. C.-G. Bornehag's fascinating presentation (4:325-330) showed that removing the floor cover and ventilating the surface of the concrete slabs for some time only resulted in a short reduction of emission rates. The probable explanation was that diffusion of the pollutant in the huge sponge of concrete was too slow for fast airing out but sufficient to reduce the air quality over the years.

Charles Weschler

Charles is at the Bell Research Corporation (commonly known as Bellcore), Red Bank, New Jersey. The following is derived from conversations with him.

Weschler observed that there is now a general realization that chemical transformation in indoor air is important. Weschler's own paper, "Chemical transformation of indoor air pollutants" (1:919) and several others addressed this. Weschler pointed out that Finn Englund from Sweden has addressed this from the perspective of the wood industry and emissions from wood products; Mark Mendell from NIOSH in the USA has recognized the importance of it in under-

standing VOC versus SBS data; Jan Sundell of Sweden was one of several co-authors of a paper that addressed it in ventilation ducts (3:947); Bill Nazaroff of the University of California, Berkeley, has been addressing it in very sophisticated modeling for years; and, Peder Wolkoff of the National Institute of Occupational Health in Denmark has even looked at the effect of oxygen content of the air in emissions tests of building products (1:579).

"...there is now a general realization that chemical transformation in indoor air is important."

Charles Weschler

A related paper by Kiyoung Lee *et al.* (Harvard School of Public Health) looked at ozone decay rates in residences (1:489). Obviously, if ozone is reacting, the reaction products will involve transformations. Sufficient data exist to support the idea that many VOCs are converted to hydroxyl radicals. Lee found that ozone decay rates increased as surface area to volume increased. Thus, carpeted homes had higher decay rates than where floors are uncarpeted.

Morrison and Hodgson (Lawrence Berkeley Laboratory, California) found exposing HVAC system materials to atmospheric ozone may result in increases in the concentrations of C_5 - C_{10} aldehydes, a group of odorous chemical irritants (3:585). We would suggest that since ozone is present in outdoor air in most urban areas of the United States, especially in the warmest months, it is not unlikely that such aldehyde formation occurs quite widely.

Claude-Alain Roulet

Claude-Alain is at the Institute of Building Technology, Solar Energy and Building Physics Research Laboratory, Swiss Federal Institute of Technology, Lausanne, Switzerland.

"Architectural aspects are now taken into account. It is acknowledged that indoor air is not (and by far) the only cause of SBS. Global environment should be taken into account (1:435, 3:229). This is very important, since solutions to SBS cannot be found in the air quality only.

"Natural ventilation and passive cooling gain consideration (3:241, 3:265). This practical, cheap and efficient way to provide convenient indoor environment in many climates (not everywhere, of course!) is compatible with sustainable development. Research work is nevertheless still required in order to provide better planning tools for natural ventilation, since natural ventilation cannot guarantee a given air flow rate. The planning tool should take uncertainties of input data into account and be able to predict the probability to be over- or under-ventilated.

"I agree with Moschandreas, who said that large statistical and epidemiological studies are still required. Until now, most of our partial knowledge is based on case studies only. For example, the European IAQ audit is still too small to draw more than very general conclusions.

"The presentation I liked the most was that of Michael Cabanac, who raised a [few] very important points: a) our choices [are] based on our pleasure, and this shall be acknowledged; b) pleasure (which is transient by essence) should not be confused with happiness, which may be permanent but boring. At Nagoya, we have experienced daily the pleasure to pass from one uncomfortable environment to the other, i.e. from an uncomfortably cold indoor environment to an uncomfortably tropical outdoor climate."

David Wyon

David is at Johnson Controls, Inc. and the Technical University of Denmark.

"It is too soon for a final verdict, but my first take on the 4000 pages of the IA '96 Proceedings is as follows:

"Important new field data on environmental factors in asthma are to be found in Smedje *et al.* (1:611), implicating MVOCs (VOCs emitted by bacteria and moulds) in Swedish schools, by Hooper *et al.* (1:641), implicating NO_2 from gas stoves in Australian homes, and by Garrett *et al.* (1:617), implicating formaldehyde in Australian homes.

"The reality of the "missing TVOC" effect on SBS (the controversial epidemiological evidence of a negative correlation between TVOCs and SBS in data from offices in northern Sweden), which when reported at Indoor Air '93 by Sundell was dismissed by many as being an artifact of confounding factors and clearly impossible, was strongly supported by an identical finding in the European Audit of 56 buildings in 9 different countries, as reported by Groes *et al.* (4:237), and a plausible explanation of the effect in terms of air chemistry was supported by experimental evidence reported by Andersson, Sundell *et al.* (3:947), showing that ozone in a ventilation system could cause conversion of VOCs to more aggressive chemical products, although it remains to be shown whether it does in practice.

"Easily the most impressive empirical laboratory results at IA '96 were provided by two landmark papers from the Technical University of Denmark. Fang Lei, Clausen and Fanger (3:3450) showed very elegantly that olfaction is powerfully affected by temperature and humidity, while these factors will usually play a significant but minor role in the rate of emission of sensory pollution from building materials. The practical conclusions are immediate: in buildings with high indoor odour source strength, keeping indoor air cool and dry may sometimes be more economical than reducing pollution levels by increasing outside air supply rates, in terms of perceived IAQ.

"Similarly, Wargocki, Clausen and Fanger (3:947) showed conclusively that sensory pollution source strengths as diverse as building materials, ETS and body odour are additive, and not just as a first approximation. Claims to the contrary are seen to be hairsplitting — readers can see for themselves that the regression is as closely linear as any relationship in behavioral science can ever be shown to be.

"The practical conclusion is that laboratory olf/decipol results on these diverse sources of indoor air pollution can indeed be combined to make recommendations on required ventilation rates for acceptable perceived indoor air quality (in terms of first-impression odour for visitors from outside). Building managers may choose to make this their guiding criterion — it seems likely to be the most demanding criterion in healthy buildings — or they may choose to ignore visitors' impressions and to maintain minimum levels of ventilation for the health, comfort and economy of their occupants.

"It is important to realize that these various criteria are different and complementary: why should the decipol level predict occupant health or even occupant perception? The former would clearly be impossible in the case of radon, CO, and other odorless but toxic pollutants, while the latter is extremely unlikely due to the familiar phenomenon of olfactory habituation. The European Audit results simply verify these truisms. The pseudo-scientific controversy surrounding these issues may now more clearly be seen to be motivated by the economic consequences of adopting ventilation standards based on one of these criteria rather than another.

"Finally, I would recommend to your attention a paper by my JCI colleague Cliff Federspiel. His "reverse engineered" method of rapidly and effectively detecting step-changes in occupancy from a knowledge of system parameters and the initial rate of change of CO_2 in exhaust air (3:395) involves some heavy mathematics: the (1994) conference paper in which it was presented was judged the most significant paper of the session by the control engineers who understand it.

"The rest of us can appreciate that the practical applications in building management are not limited to demand-controlled ventilation, but may extend to lighting control (detecting occupants), security (detecting intruders) and fire prevention (detecting smoldering concealed fires), once CO_2 detectors become cheap enough to be located in every zone, or even in every room, and connected to a central building management computer."

David Grimsrud

David is the Director at the Minnesota Building Research Center, University of Minnesota, Minneapolis. His comments were lightly edited by the ***BULLETIN****.*

Grimsrud identified several basic issues after the conference. These are broad perspectives reflecting his many years of work in the indoor air field.

The Importance of Setting Priorities

Global health effects were perhaps best characterized by Kirk Smith, a researcher who is now at UC Berkeley who has spent much of his career examining air pollution within structures in developing nations of the world. It may be cynical to note that only the developed countries of the world can afford to be concerned about IAQ. From a humanitarian point of view we cannot allow that to be. Smith and Dieter Schwela of WHO argued strongly that modest help from the developed countries could have enormous impact on the health of children in developing countries. The statistics are rather astounding. Smith estimates that air pollution and poor sanitation in kitchens of the world have been responsible for more death in children 5 years and younger than all the deaths caused by the violent wars that our globe has experienced in this century. Air pollution, causing acute respiratory infections leading to pneumonia, carries a major share of this burden since half the world population cooks or heats with simple stoves using biomass or coal for fuel.

The SBS Confusion

The lack of clearly defined patterns in diagnosing causes continues to be a problem. It is clear that the symptoms are present. What is not clear is what they mean and how they are related to the workplace. We seek a consistency of explanations for these symptoms. These explanations continue to elude those who seek it.

The study of indoor air quality is often described as an interdisciplinary topic. It may be, as one distinguished speaker noted, that the solution to SBS will only come from an inclusion of a wider collection of disciplines from outside the natural sciences such as those involved in labor-management mediation and experimental psychologists.

Good Ideas Must Sometimes Be Abandoned or Modified — Olf/Decipol and TVOC

The olf/decipol idea that was introduced by Prof. Fanger with great fanfare at Indoor Air '87 in Berlin is under significant pressure. A large European survey of buildings in nine countries showed results that disputed its predictive ability when used by a broad range of field personnel. Since then there have been other attempts to improve its predictive power. In an eloquent presentation in Nagoya, Professor Fanger defended the approach and pointed to new results by Lei Fang (from Fanger's laboratory) that suggest that perceived air quality is a function of the temperature and humidity of the air that is breathed.

"...the solution to SBS will only come from an inclusion of a wider collection of disciplines from outside the natural sciences such as those involved in labor-management mediation and experimental psychologists."

David Grimsrud

The changes to this model may make it more complicated than a conventional approach. I note this with some sadness. The olf/decipol model has had an elegant simplicity about it that made it appealing as a transition from the condition in which we simply prescribe ventilation rates assuming that body odor is the only source of pollution to the point where we understand the health effects of the pollutants that will be found in indoor air and simply model the air quality based on the known characteristics of the materials that are in the space. We are far from the latter condition today. The olf/decipol model might have been an appropriate transition model.

Another victim of progress in understanding appears to be the notion of TVOC or total volatile organic compounds. This idea was also introduced by a Dane — in this case, Prof. Lars Mølhave from the University of Åarhus. Those who study volatile organic compounds (VOCs) are often dismayed by the complex mixtures of compounds seen in measurements. Mølhave introduced the idea a decade ago that one could simply add together the mass of organics seen in a sample and from this result estimate the acceptability of the indoor space. He produced guidelines that have been adopted widely: if $C < 300\ \mu g/m^3$, the space is unlikely to cause irritation; if $C > 3000\ \mu g/m^3$, irritation is likely. The response for concentrations between the two limits is uncertain.

Analytical chemists have been particularly critical of this approach. They point out that the TVOC result obtained depends critically on the sampling approach used; that adding masses involves combining masses of chemicals that cause much different responses in people. The lack of correlation between symptoms reported in SBS investigations and measurements of TVOC has led people to consider alternative hypotheses. One is that we should be examining some of the very reactive species of airborne compounds seen in the air. They will interact with other species and cause new compounds to form; the reactive species are likely to be the most irritating.

At any rate a simple rule of thumb that had much appeal seems to be a poor predictor of the behavior of this complex air mass we find ourselves immersed in each day.

Progress on Source Emission Databases

I was encouraged by the progress that was discussed in obtaining information about the emission rates of materials used in buildings and the progress disclosed by many groups to assemble these values into data bases that will be acceptable to building designers. In some cases, these data bases are being merged into guidelines that will be applied to future buildings. An example is that created in Finland. The document, "Classification of Indoor Climate," sets limit values for thermal comfort and various pollutants, sets guidelines for cleanliness of installation of equipment, and limits emission rates of commonly used finishing materials that will be used in the space. I note in their list that they limit TVOC to an emission rate less than 200 $\mu g/m^2/h$ for their category A occupancies. That category may be forced to change.

Global Nature of Health Problems and the Regional Nature of Solutions

Health effects are recognized as global issues. The word global is used here as a term for universal. Thus, observations that evidence of moisture damage in housing could be associated with respiratory problems in children in the United States, Canada, the Netherlands and the UK has been corroborated by studies in Finland and in Taiwan. In Finland, the epidemiology was carried forward to include health effects in adults and to a study of the mechanisms involved. Nevalainen and col-

leagues studied micro-organisms commonly found in moldy houses and showed that two varieties, Streptomyces A4 and Streptomyces A91 promoted the production of NO. At the cellular level, NO is important in the immune system but excessive production can lead to tissue damage and may be involved in the pathology of several diseases including asthma.

I have been discussing results presented at the Nagoya conference to this point. I do not want to slight the exciting results presented at Yokohama. In a very important sense those results are an indication of how architects, engineers, and other building professionals solve problems in different countries.

"ROOMVENT" (held in Yokohama the week before Indoor Air '96) represented a subset of the topics covered at the Indoor Air conference in Nagoya. It examines ventilation design issues, modeling air motion using computational fluid dynamics (CFD), and applies these to specific building issues. We heard descriptions of the CFD simulations that were part of the design preparations for the Kansai International Airport and the Tokyo International Forum; and, we were impressed by the latest applications in CFD simulations such as the study of the thermal environment around the human body presented by the Murakami group. This simulation is important for the understanding of personal exposures to air pollutants.

This approach to problem solving is not done in many countries outside of Japan and Scandinavia. It is important that these techniques and skills be used more widely.

Another thread that we began to hear at both conferences was a call to designers to respect the accumulated wisdom of past designers in their regions and attempt to incorporate these ideas into modern buildings. This theme was a part of presentations by Professor Kimura of Japan, Professor Spengler from the U.S., Dr. Lee from Korea, and Dr. Maki from Japan. The wisdom I am referring to deals with using the regional climate as a part of finding the appropriate climate-control strategies for a building. Since the local climate helps to define a region, the set of solutions that will be found will be different for the different regions of the world.

Lack of Participation from the United States

This may be a topic that is important only for me. I found the lack of participation from the United States in both conferences embarrassing. The U.S. has not had a major role in ROOMVENT in the past — however, it is an appropriate area to begin to enlarge. The lack of participation in Indoor Air '96, however, is more discouraging. There was no participation from the traditional areas that are funded by the U.S. government: EPA, DOE and the national laboratories. The void was noticeable and regrettable. The government presence is essential to balance special interests that represent the logical extremes of our capitalistic system.

Modest Role of Radon

Papers relating to radon had a modest role in the Nagoya conference compared to the past. This is an example of a topic where the fundamental questions are those of policy implementation. We understand the risks and the health effects. Excellent remediation strategies have been developed.

Reemergence of CO as an Issue

Carbon monoxide, a pollutant caused by imperfect combustion, was one of the first indoor air pollutants studied as this field developed. During the eighties attention shifted to nitrogen oxides as targets of combustion studies. Recently a class of CO alarm devices have begun to be marketed to homeowners with the result that wide-scale interest is developing once again in CO, its sources, and health effects. One paper presented in Nagoya described the effects of CO exposure to pregnant mice on the health of their newborn mice pups. The results indicate a decrease in their ability to survive.

This result would have major implications for the issue that was listed first in this list of questions: the impact of unvented combustion for heating and cooking on the health of children world-wide.

The conference proceedings are a rich source of new ideas and directions that the study of indoor air quality is taking.

Kirk Smith

Kirk is a professor at the School of Public Health, University of California, Berkeley.

"The kitchen kills more than the sword." (Latin proverb from Smith's plenary lecture.)

Kirk Smith delivered a plenary lecture on the oft-neglected subject of indoor air quality in lesser developed countries (LDCs). His lecture (as well as a related one by Dr. Dietrich Schwela of the World Health Organization) put the rest of the conference in perspective. Smith told us that the majority of the women in the world are exposed daily to concentrations of particulate matter more than one to two orders of magnitude higher than those experienced by most European, North American, and Japanese women.

Particles formed by the combustion of crude biofuels result in concentrations in the 1 to 10 mg/m^3 range and higher. Smith himself reported measuring concentrations as high as 50 mg/m^3 and he showed a photograph taken in a home where this occurred. Visibility was about one meter. He pointed out that we know so little about the health effects of exposures above 100 µg/m^3 (0.1 mg/m^3) that we are in the unique position of extrapolating upwards from health effects data obtained in industrialized countries to try to understand the effects of such large exposures. Important policy decisions cannot be made confidently with such large uncertainties. For example, as Smith pointed out, we don't know the shape of the dose response curve above 100 µg/m^3 so strategies to reduce exposure from 10,000 µg/m^3 to 1,000 µg/m^3 may or may not be very productive.

"The kitchen kills more than the sword."
Kirk Smith

No large scale studies have been done, either to characterize exposure or to understand their health effects. Policy-makers simply lack the basic information they need to address the exposures of this enormous segment of the world's population. Smith was attempting to get support from the international community and its two most prominent organizations, the International Society of Indoor Air Quality and Climate (ISIAQ), and the International Academy of Indoor Air Sciences. Neither took formal action to endorse his proposed policy statement, a statement of concern and commitment to offer its expertise, or on a proposal for a "simple, inexpensive global monitoring system to track and promote clean indoor air in developing country households."

We believe his proposals are worthy of support, long overdue from the indoor air community.

The *BULLETIN* Sees Some Trends

Many researchers are identifying sources of the VOCs found in indoor air. These sources include both micro-organisms as well as building materials, consumer products, and outdoor air. A recently published paper by Weschler and Shields (*Indoor Air* Vol. 6, No. 1) as well as papers on the European Audit Project presented at Healthy Buildings '95 have done this before (HB '95, Vol. 3). This is potentially a very useful endeavor. Logical groups of VOCs might allow the use of indicator compounds so that all compounds do not have to be characterized (identified, quantified). Better and quicker understanding of the sources of contaminants will facilitate source control in the remediation or mitigation projects and will reduce the effort required by researchers to characterize emissions from realistic building material assemblies.

As pointed out by Roulet, there is more attention to the impacts of buildings on the global environment including our own as well as several other papers. There is more attention to interactions among factors as represented by the work of Lei Fang, Clausen and Fanger (3:349) discussed by Wyon, the paper of Ole Valbjørn (3:729), and, again, our own paper (2:741).

There were numerous papers at Nagoya that evaluated contamination of HVAC systems and especially by microbial growth on filters and system components (3:125, 137, 143,161, 167, 173, 191, 197, 203). These papers all reported microbial growth. Temperature and humidity were found critical to the rate of growth as well as the rate of death. Various media filters were studied and results were not consistent among the various authors. There were many more papers on microbial contaminants including studies in houses, in ventilation systems, in schools, and in laboratory settings. In general, understanding of microbial contamination and its association with occupant health effects appears to be reaching the stage that VOCs reached some time ago and may even be more advanced and more useful. Microbial species are usually identified rather than simply counting total colony-forming units. Metabolites of the organisms (MVOCs) are being characterized more frequently although mostly in the laboratory at this point. Aino Nevailinen reported that occurrence of micro-organisms is remarkably similar around the world, at least in controlled indoor environments.

Finally, there seem to have been far more papers that combine modeling with field data. This, we believe, is the most fruitful type of research. It enables us to move forward more economically by enabling us to do more with less field data. Over time, as the models are validated by the range of field situations in which they might be used, the models will be reliable enough that we will need very little data to make predictions for design, remediation, or other purposes.. The ultimate contribution is toward developing a theoretical base that can lead to the creation of a useful science.

Moschandreas Summary

According to Demetrios Moschandreas, the field is still lacking in terms of certain basic measurement capability, suffering from a continued abundance of case study reports, lacking consistency in measurement

methodologies employed, and lacking a common terminology for some of the most basic concepts and physical materials, Moschandreas' conference summary lecture was the basis for the following article written by him for this issue of the ***BULLETIN***.

For a Copy of the Proceedings:

Contact Indoor Air '96 via Dr. Koichi Ikeda, Secretary, INDOOR AIR '96, The Institute of Public Health, 6-1, Shirokanedai 4-chome, Minato-ku, Tokyo 108, JAPAN, e-mail: iwata@iph.go.jp, fax: +81-3-3446-4723.

The set of four volumes plus the program (schedule, sessions, and author index) costs JYE 20,000 plus shipping. Shipping by sea (one-two months) costs JYE 2,700 and by air mail (one week) costs JYE 4,250 to Asia, JYE 7,250 to Africa or South America, and JYE 5,460 to Europe, North and Central America, Oceania, Middle and Near East, etc.

AMEX, DINERS, MASTER, and VISA credit cards are accepted. Send the following information by mail or fax: name of card holder, card no., expiration date, signature, and date. (Please note that the billing address of the credit card has to be the same as the mailing address for the books.)

Lecture

Indoor Air Quality — the Present

The IAQ '96 Summary Lecture

This lecture was presented at Nagoya by D. J. Moschandreas, Ph.D., of the Department of Chemical and Environmental Engineering, Illinois Institute of Technology.

Introduction

The IAQ series of international conferences on indoor air quality and climate began in 1978 in Copenhagen, Denmark. Eighteen years later, many (nearly one thousand) engineers, architects, medical doctors and experts from other related disciplines have gathered in Nagoya, Japan to present their findings, exchange opinions and determine the future avenues of inquiry in indoor air sciences. Participants of this conference help determine the state-of-the-art of indoor air in scientific sessions and workshops, and discussions in the corridors of the conference center and during social activities.

This paper will not review the findings of the papers presented, the session chairs have accomplished this task. This paper will not discuss specific future directions of indoor air sciences, this was also addressed earlier in the conference. This paper will summarize the findings by synthesizing the highlights of the conference and referring to a few general concerns that surfaced by the end of the conference. In the process of formulating this summary, some points may be missed and some others may be misrepresented; all participants can be assured that these errors are errors of omission and not of commission.

The theme of this summary was articulated by participants a few times explicitly and several more times implicitly. The IAQ '96 findings will be summarized by addressing the following theme: Is the quest for knowledge on indoor air quality and climate a mature scientific discipline? The alternative would be the realization that we are scientists from several related disciplines and professionals from diverse fields who meet every three years in several cities of the world merely because we perform our experiments and study inside enclosed environments.

Conference Summary Statistics

Papers presented in a conference may be summarized in accordance with their subject and the microenvironment they studied. Table 1 provides information on paper subject and microenvironment from IAQ '96, it is a matrix relating study microenvironments with subjects of inquiry. Depending on their subject content, papers presented in this conference have been assigned in one or more of the following eight subjects of inquiry: pollutant measurement, thermal comfort, health effects, exposure, models and theory, controls, ventilation rate and energy, and perception and questionnaires. Similarly, depending on the microenvironment(s) the papers purport to study, the papers have been assigned to one or more of the following eight microenvironments: residences, schools, hospitals, large buildings, special environments, laboratories, all environments, and theoretical works.

Of all papers presented, 21 percent involved measurement as the study objective, while 18 percent dealt with environmental control. The subjects addressed by the smallest portion of papers were exposure, five percent, and perception and questionnaires, four percent. Thermal control, health effects and theoretical studies

were the subject of 14, 15, and 10 percent of the papers presented, respectively.

Three categories of paper frequency surface when the papers are classified according to the microenvironment studied. The first category includes residential studies and theoretical studies, each had twenty percent of the studies presented. The second category refers to the frequency of paper presentation on large building, laboratory, and all microenvironment studies, it was between 13 and 16 percent. The small portions of presented papers on schools, five percent, hospitals two percent and special environments, four percent, is the last category. Each of the 64 cells in Table 1 contains two numbers: the number on the left is the portion of all studies in that microenvironment addressing that subject, the number in the right of each cell is the portion of all papers in the subject that is studied in that microenvironment.

The large number of papers on pollutant measurements and control strategies was anticipated. The relatively large portion of papers on thermal comfort, on modeling and theory, and on health effects is welcome and indicates continuing and increasing progress and interest in these areas. The small portion of papers in exposure and perception is noteworthy and will be discussed later. While the interest in large buildings is apparent, one must mention that papers specifically on Sick Building Syndrome were not abundant. The portion of laboratory studies and on theoretical studies indicates a strong association between theory and validation efforts in indoor air investigations.

Assessment By Issue

Clearly, an assessment of all 64 cell/topics addressed in this conference is not feasible. Instead, the following four general issues will be discussed: exposure, perception, controls and policy. Exposure is an all-inclusive topic that includes studies of indoor air measurements, instrument development and or improvement, experimental design, and risk analysis. In this context, instrument design does not refer only to instruments measuring pollutants but also to questionnaires and other survey instruments. One can also understand exposure as the first step in risk assessment which, in turn, involves studies of health effects. In view of this inclusive interpretation of the term exposure, it is not surprising that a large number of measurement papers was presented. These papers studied all inorganic, organic, and bio pollutants with an emphasis on measurement of organic pollutants and biopollutants. Several papers were presented on improving, calibrating, and comparing measurement instruments. It is recognized that too much emphasis on certain instrument development and improvement

Table 1 - Statistics of papers by subject and microenvironment. *Each of the 64 cells in Table 1 contains two numbers: the number on the left is the portion of all studies in that microenvironment addressing that subject, the number in the right of each cell is the portion of all papers in the subject that is studied in that microenvironment.*

Subject content category:	Measure-ment	Thermal comfort	Health effects	Exposure	Models, theory	Controls	Ventilation rate, energy	Perception, questionnaires
% of all papers:	(21)	(14)	(15)	(15)	(10)	(18)	(14)	(14)
Micro-Environment:								
Residences (22)	32/34	17/16	17/24	04/13	04/09	14/17	11/18	04/15
Schools (05)	12/03	12/04	53/18	06/07	12/06		06/02	
Hospitals (02)	43/04	14/04					28/04	14/08
Large buildings (16)	29/22	08/09	18/18	02/07	06/09	12/10	18/02	08/30
Special environments (04)	67/12	06/02				25/05		
Laboratories(14)	04/03	28/28	09/08	02/07	06/09	35/27	15/16	
All buildings (13)	07/01	02/02	12/10	12/33	19/24	41/35	02/02	02/08
Theory (22)	15/18	17/26	15/22	07/33	21/44	10/12	24/38	04/23

may be disproportionate to the needs of indoor air sciences, yet the comparative efforts will lead to results of more uniform quality.

Exposure studies in the more conventional sense are survey investigations that require experimental designs and lead to risk analysis. Papers on exposure studies in this conventional sense were almost totally missing, and only a few papers addressed risk assessment. This reflects the lack of such large studies in the recent past. This type of study, however, will be presented in IAQ '99 because two such studies are under way, one in Europe and the other in the USA.

Components of perception studies include questionnaires, surveys, psychology, and sensory studies. The number of papers presented was not large, but the few presentations were distinguished by their quality and the extensive use of statistics. A surprising finding was reported: perception correlates well with pollutant concentrations. This is in conflict with past studies, and with results from a paper presented in this conference which concluded that increasing the mechanical ventilation of a large building decreases indoor pollutant concentrations but does not affect the perception of the occupants of and visitors to the building.

The regulator and those who are likely to be regulated are aware of the efficiency of mitigation strategies. Papers presented in this conference addressed control technologies, HVAC systems and their efficiency, and the ability of the systems investigated to affect a reduction of pollutant levels in indoor environments. Only a few new systems were proposed, but the emphasis was on model and model validation studies. Several novel ideas were presented on building diagnostics, commissioning, and their impact on the life of a building.

Policy and regulation considerations are based on potential health effects, ability to reduce risk, and socioeconomic factors. These subjects attracted considerable attention during the conference, it became evident that not all indoor air experts/participants of this conference realize the difference between guidelines and standards and the existence of several guidelines — both guidelines on pollutant levels and ventilation rates in many countries throughout the world. As a result, there is a diversity of opinion on the need and effectiveness of indoor air regulations and guidelines. However, there is unanimity of opinion that information on the importance of indoor air quality should be distributed to the public.

Highlights and Concerns

Different methods were used in different countries to measure the same indoor air variables. A diversity of needs and the impact of geographic, climatic, and social factors surfaced from the findings of similar studies from several countries. International conferences, such as IAQ '96, induce comparisons of findings as a function of the location of the measurement. Unexpectedly, an overall uniformity of pollutant levels in specific microenvironments became evident independent of the city and nation of the study. The exception relates to developing countries, addressed below.

Indoor air quality studies require inputs from architects; this is a fact that no one may challenge. Unfortunately, the absence of architects in previous IAQ conferences was noticeable. One of the higblights of IAQ '96 is the participation of nearly two hundred, I am told, architects. There is still a need for greater emphasis on building design issues. Their presence and inputs were welcome and one hopes that this conference established a precedent to be followed.

More than any previous conference, IAQ '96 paper presentations focused on indoor pollutant levels in developing countries. These pollutant levels are extremely high. The IAQ '96 participants are called to take a leadership role in educating the world about these unacceptable conditions and in providing strategies and techniques for reducing pollutant concentrations to more conventional and acceptable levels.

The significance of indoor air guidelines was emphasized again in sessions, workshops, and corridors of the conference. It is a driving force in this area of inquiry, yet several of the participants were not aware that many countries have indoor air and ventilation guidelines and that there is literature on guidelines and their function.

A rather large number of investigations sought to investigate cause-and-effect relationships, the mechanisms that explain the observed data. This, coupled with model development and model validation studies, constitutes a change of direction of indoor air sciences that places greater emphasis on explaining the observations than just making and using the observations. This greater focus on science will provide strong impetus for future work.

A large number of case studies was presented in the conference. This is a necessity that leads to the following concern: conclusions were reached from studies with an extremely small sample size and no statistical justification. During the session summaries, one of the chairs was "delighted" to see error bars in a presenta-

tion. I and, I am sure many others, share his delight, but the use of statistical tools should be the norm rather than the exception.

On several occasions, participants discussing an issue used the same words but meant different concepts. Discussions under such conditions are not productive and lead to frustration. The leaders of this scientific community should consider the possibility of composing a glossary of important terms and concepts.

Few papers focused on exposure and even fewer on risk assessment studies. The indoor environment is the environment where individuals spend most of their time and, therefore, is a potentially major component in the analysis of risk. The lack of indoor risk assessment studies is puzzling and may relate to the next point of concern.

Table 1 illustrates the portion of papers in sixty-four different categories. Another way to categorize the papers presented is to divide them in engineering papers and "other" which includes health effects and perception studies. Only 20 percent of the papers presented fall under the "other" category. The indoor air quality scientific community is not an engineering branch of inquiry; we need a greater balance of inputs. The objective of our studies is to protect the occupants of indoor environments. In order to respond comprehensively to this mission, we must seek inputs and participation from medical doctors, toxicologists, and epidemiologists.

Conclusion

Early in the conference series we knew we had a reason for concern and wondered if there was cause for panic, today we continue to be concerned but the potential for panic is reducing substantively. We, as a community, know the magnitude of the problem, understand some of the causes and mechanisms, work toward designing mitigation strategies, and assist the regulator to manage the risks.

Are we a mature scientific discipline? We have a mission, we have a scientific process, we have our own culture with our philosophers and politics, we have identified needs that can not be answered by one single conventional discipline. Indoor air science is not an academic discipline with common language and a common set of principles for evaluating new ideas. But ,we are a multi disciplinary science. As such we have been a scientific entity for about twenty years. Are we mature? Chronologically we are maturing and growing into a unique multi-disciplinary science. With the help of conferences like IAQ '96 and greater effort to be more inclusive we are on our way toward achieving our goal of protecting the indoor environment and its occupants.

Correction

European Audit Project VOC Data

Figure 4 in Volume 3, No. 5 showed VOC average indoor concentrations in 56 buildings from nine countries participating in the European Audit Project (Cretton *et al.*, 1995). A letter from Stefan Mogl of BIGA in Zurich, where the VOC analysis was performed, revealed a discrepancy between the data reported in our article and those reported in the Final Report of the project (Bluyssen *et al.*, 1995).

In particular, the German values shown in the ***BULLETIN*** were quite high, perhaps from a data entry error. Figure 1 shows the actual values reported in the Final Report of the European Audit Project.

As seen in the graph, the data indicate that with few exceptions, TVOC concentrations were less than 1.0 mg m^{-3}, and, in most cases, they were less than 0.5 mg m^{-3}. While there were significant variations among buildings in most of the countries, the between-country variations were also large in some instances.

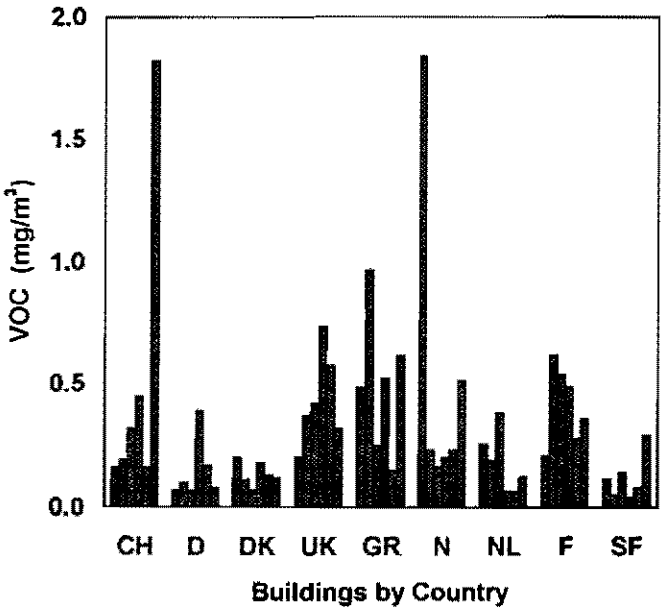

Figure 1 - Average TVOC Concentrations from 56 Buildings in 9 Countries from European Audit Project (Bluyssen *et al.*, 1995).

Large Building Study

EPA Base Study

EPA initiated its Building Assessment Survey and Evaluation (BASE) Program to fill the gap in baseline IAQ data for public and commercial office buildings in the US. The purpose of the project is to define the status of the existing building stock. Randomly selected buildings are monitored using a standardized protocol including EPA method TO-14 to measure VOCs. Figure 2 shows the results of the VOC measurements. The authors note that the single value in excess of 0.6 mg/m^3 was from the contribution of dichlorodifluoromethane (freon) which presumably indicated a leak in an air conditioning system. Note that the measurements shown in Figure 2 reflect the concentrations only of the compounds that were identified.

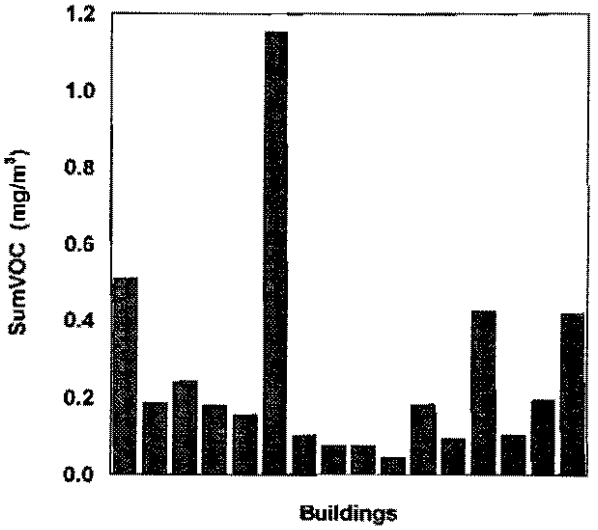

Figure 2 - EPA "BASE" Study Sum VOCs in 16 randomly selected buildings (Brightman *et al.*, 1996)

Conferences

Indoor Air '99 in Edinburgh, Scotland

At each Indoor Air 'xx conference, the members of the International Academy of Indoor Air Sciences elect the president of the next triennial conference. Three nominations were received for Indoor Air '99, including strong proposals from Lidia Morawska of Australia and Sten Olef Hanssen of Norway. The members of the Academy selected psychologist Gary Raw as president of Indoor Air '99 based on a proposal to hold the 8th International Congress on Indoor Air Quality and Climate in Edinburgh, Scotland, August 8-13, 1999.

The person chosen by the Academy as conference president is responsible for all the technical, social, and financial aspects of the conference. Needless to say, it is an enormous undertaking, and the success of the conference is strongly determined by the leadership of the president. Equally important are the members of the national organizing committee whose members share much of the responsibility.

Gary Raw is a psychologist in the Healthy Buildings Group at the Building Research Establishment (BRE) in Watford on the outskirts of London. Raw has been involved in numerous IAQ studies at BRE since he began work there some 10 years ago. He was previously a Research Fellow at the University of Surrey, England, where he is now a Visiting Professor.

On the occasion of the 8th conference, the indoor air series will reflect on 21 years since the first meeting in Copenhagen in 1978. The field has grown and matured tremendously since that time. As it "comes of age," it is still seeking its identity within engineering, health science, architecture, building construction and management, and other important component fields.

The site of the conference, the Edinburgh International Conference Centre, is a recently completed state-of-the-art facility that promises to provide some new opportunities based on the latest high-tech equipment. Edinburgh itself is an ancient and beautiful city with many opportunities for cultural as well as aeademic exploration. We anticipate an interesting and successful event again in '99.

To make sure you get on the mailing list, send your business card or a note of your name and contact details to Professor G. J. Raw (Indoor Air 99), Building Research Establishment, Watford WD2 7JR, United Kingdom, Fax +44 1923 664088, email: aizlewoodc@bre.co.uk.

IAQ Standards

ASHRAE Standard 62R, Ventilation for Acceptable Indoor Air Quality: The Next Generation

The draft revision of ASHRAE Standard 62, perhaps the single most important IAQ document anywhere, is scheduled to begin the formal public review period August 15. After more than five years and around two dozen meetings — more than half of them lasting two and one-half days — the proposed revision of ASHRAE's "Ventilation for Acceptable Indoor Air Quality" (Standard 62R) has been approved for a 120-day Public Review and comment period.

The draft standard received approval for public review at ASHRAE's Annual Meeting in San Antonio in June. ASHRAE has announced the availability of the Public Review draft. See the August issue of the *ASHRAE Journal*. The draft is available over the Internet at no cost. Floppy disk and hard copy versions are also available from ASHRAE.

The public review draft 62R is far lengthier and more detailed than the existing standard, 62-1989. It contains many changes from the current standard, 62-1989, many of them in the form of expanded scope. The draft is written in code language to facilitate adoption by states and municipalities. This has made the draft standard's language less ambiguous albeit more demanding.

In addition to establishing ventilation rates — the main focus of the standard in the past — the draft 62R addresses details of design, construction, operation, and maintenance that will contribute to better IAQ. The draft addresses control of indoor air pollution sources as well as ventilation in a previously unprecedented way. Much of the attention is on the design, construction, operation, and maintenance of mechanical ventilation equipment and systems.

Opponents of the draft standard have been vocal. Not surprisingly, tobacco industry representatives and consultants are prominent among those who have weighed in against it. Since the provision of "acceptable indoor air quality" in the draft Standard 62R does not accommodate tobacco smoking and the current Standard 62-1989 accommodates a "moderate amount of smoking," tobacco interests' motive is obvious. This well-funded group has mounted a vigorous opposition campaign.

Joining the tobacco interests in opposing the draft standard are some representatives of the housing industry who seem to have a knee-jerk reaction to any regulation or change. Many engineers find the detailed requirements of the draft too complicated or burdensome. Others oppose further spreading of the burden among the various sectors for achieving acceptable IAQ. This includes some equipment manufacturers and building owners. At the same time, many equipment manufacturers and building owners see the draft revision as beneficial by creating new markets and clarifying the responsibilities of the various parties involved in achieving good IAQ.

There is relatively little controversy apart from the requirements related to ventilation rates. That is where tobacco smoking is explicitly not permitted where acceptable IAQ is to be achieved, and that is where some of the more complicated, at least on first inspection, requirements occur. In fact, there are some alternative ways to determine ventilation rates that are quite simple and vastly improved over the existing standard.

Among the most impressive and lowest-cost changes in the standard is the detailed list of design and system documentation requirements along with the ways in which the documentation must be passed along, maintained, and updated. This will facilitate and even necessitate much needed communication among designers, owners, operators, and even building occupants. It will force articulation of the basic assumptions about what a building is expected to handle in terms of pollution loads and how it is expected to handle them. It will create a record, intended to be accurate and up-to-date, that will allow designers, operators, and facility managers to understand exactly what the building was expected and designed to do to provide good IAQ.

An article in the next issue of the ***BULLETIN*** will highlight some of the more significant changes in the draft standard.

For a copy of the Public Review Draft:

The draft is available at no cost on the Internet: www.ashrae.org. Click on: *Research and Standards/Standards/How to access standards on ASHRAE's FTP site.*

Paper and electronic copies are available from ASHRAE. The cost is $25, which includes both paper and electronic versions of the draft in Microsoft Word 6.0 format on 3-1/2" diskettes. A Word viewer program is provided for users without Microsoft Word 6.0.

To obtain a copy, contact Customer Service, ASHRAE, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305, 404 636-8400, Fax: 404 321-5478.

Calendar of IAQ Events

September 16-18, 1996. **Indoor Air Pollution: Ninth Annual Conference**, Orlando, Florida, Organized by University of Tulsa. Contact: Univ. of Tulsa, Division of Continuing Education, 600 South College Avenue, Tulsa, OK 74104-3189, 918 631 2347, Fax 918 631 2154. *Special feature: One day presentation on bioaerosols by Harriet Burge, Harvard School of Public Health. Registration: $450. Group discount fee: $300/person. The meeting will also feature a panel with attorneys and experts from both sides involved in the controversial Martin County, Florida, lawsuit.*

September 23, 1996. **Building Diagnostics Course**, Falls Church, VA, Sponsored by Virginia Polytechnic Institute and State University. Contact: Alexander J. Willman, P. E., Center for Building Health, Safety and Productivity, 703 698 4720, Fax 703 698 4729, email: awillman@vt.edu.

October 6-8, 1996. **IAQ '96, Paths to Better Building Environments**, Omni Inner Harbor Hotel, Baltimore, MD, sponsored by ASHRAE and several other organizations. Contact ASHRAE Meetings Department, 1791 Tullie Circle NE, Atlanta, GA 30329. 404 636 8400, Fax 404 321 5478. *There should be some interesting lectures, papers, and workshops at this tenth anniversary IAQ conference. Workshops will focus on IAQ and ventilation in schools, IAQ for medical facilities, and CO2-based demand controlled ventilation. Tutorials will cover fundamentals of air cleaning, measuring indoor air contaminants, moisture and microorganisms, and design considerations from ASHRAE Standard 62-1989R. There will, no doubt, be plenty of discussion of the public review draft of Standard 62R.*

October 13-16, 1996. **SMACNA 53RD Annual Convention**, Grand Wailea Resort Hotel, Maui, Hawaii. Contact: Rosalind Price Raymond, 4201 Lafayette Center Drive, Chantilly, VA 22021-1209, 703 803 2996, Fax 703 803 3732.

October 29-30, **ASTM Committee D22.05 on Indoor Air**, Hyatt Regency, New Orleans, LA. Contact George Luciw, ASTM, ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. 610 832 9710, Fax 610 832 9666, email gluciw@astm.org.

November 17 - 19, 1996. **Thriving in the Green Building Marketplace, 3rd Annual Conference and Trade Show**, San Diego, California. Presented by U. S. Green Buildings Council. Contact: USGBC, c/o Concepts Marketing and Trade Show Management, 6540 Lusk Blvd. Suite C-124, San Diego, CA 92121, 619 535 0050, Fax 619 535 8252, email planners@conceptsmeet.com. *The Green Buildings Council calls itself "the building industry's only balanced non-profit consensus coalition promoting the understanding, development and accelerated implementation of 'Green Building' policies, programs, technologies, standards, and design practices." Advertised as a conference for "all sectors of the building industry." Co-sponsors include NIST, American Institute of Architects, and the Construction Specifications Institute, among others.*

December 8-11, 1996. **Risk Assessment and Risk Management: Partnerships Through Interdisciplinary Initiatives**, sponsored jointly by International Society for Risk Analysis and International Society for Exposure Assessment. Fairmont Hotel, New Orleans, Louisiana. Contact: Society for Risk Analysis, 1313 Dolley Madison Blvd., Suite 402, McLean VA 22101, 703 790 1745. Exhibitors contact Lori Strong or Sue Burk at 703 790 1745, Fax 703 790 2672.

January 25-29, 1997. **ASHRAE Winter Meeting and Exposition**, Philadelphia, PA. Contact: ASHRAE Meetings Department, 1791 Tullie Circle NE, Atlanta, GA 30329. 404 636 8400, Fax 404 321 5478.

September 28 - October 2 1997, **Healthy Buildings/IAQ '97: Global Issues and Regional Solutions**, Washington, DC. Organized by ISIAQ, ASHRAE, and Virginia Tech. Contact: Professor James E. Woods, Virginia Tech, Fax 703 698 4729. email: hbiaq.97@vt.edu. *Announcement and Call for Papers have been issued. Abstracts are due November 30, 1996.*

International Events

September 28 - October 1, 1996. **CIBSE/ASHRAE Joint National Conference**, Harrowgate, UK. Chartered Institution of Building Services Engineers (CIBSE) and ASHRAE. Contact: in the UK, CIBSE, +44 (0) 181 675 5211, Fax +44 (0) 181 675 6554, email: info@cibse.org; in the U.S., ASHRAE, 404 636 8400, Fax 404 321 5478.

June 9-12, 1997. **Buildings and the Environment**, Orgauized by CSTB and CIB T18, Paris, France. Contact: Ms. Angela Ghivasky, International Affairs, CSTB, 4, Avenue du Recteur Poincaré, 75782 - Paris Cedex 16. FRANCE, +33 1 40 50 29 13, Fax +33 1 40 50 28 76, email ghivasky@cstb.fr.

August 30 - September 2, 1997. **Clima 2000**, Brussels. Organized by Belgian Royal Technical Society of Heating, Ventilation, and Related Technology Industry (ATIC), on behalf of Federation of European Heating and Air-conditioning Associations (REHVA). Contact: Clima 2000 '97, c/o SRBH, Ravenstein 3, B-1000 Brussels, Belgium, +32 (0)2 511 7469, Fax +32 (0)2 511 7597. *The conference language will be English.*

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