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SBS Studies – What They Actually Tell Us

More and more SBS studies are appearing, and the factors that increase SBS symptom occurrences are becoming increasingly clear. However, few studies show direct causality, and addressing the causes is what building designers, owners, and operators want to do. Lawsuits are arising in disturbing numbers, and the nearly one-million dollar jury award in the recent EPA employees' lawsuit is a particular cause for concern.

Why is it so hard to show causality? Some of the answers rest in the way the studies are done. Critics often point to poorly designed or executed studies; many researchers attribute their studies' shortcomings to limited resources. Most studies suffer from some of each. Some fundamental research problems are likely to exist regardless of the funds expended. For example, it is unusually difficult to study phenomena with no demonstrable illness or documentable causal exposure.

It's a frustrating situation. Researchers often find that certain environmental factors are associated with the occurrence of symptoms, but they caution us not to interpret their findings as proof that the conditions caused the symptoms. Indeed, the findings of various researchers are not consistent. The case of VOCs is typical of many suspected causes of SBS symptoms. Some researchers report associations between VOC concentrations and SBS symptom rates, others find no associations, and one even found a negative correlation!

Most respected authorities agree that SBS is not a single disease, and that numerous factors contribute to elevated symptom prevalence in complaint buildings and in non-problem study buildings. We have long believed that in studying the environmental and other factors associated with higher SBS symptom reporting frequencies, combining several health and comfort outcomes into a single set of symptoms called SBS will decrease the ability of the study to detect the very associations it seeks. A study will best be able to detect associations with a disease if it combines in the analysis the specific symptoms actually associated with the disease. If what we call SBS is comprised of separate but overlapping syndromes with distinct causes, data analyses will best find any actual associations if they combine just the right symptoms and just the right exposure for a particular syndrome or disease mechanism.

Therefore, even separating symptoms into a small set of groups may not be sufficient, although such an approach has been relatively more successful than the overall single "SBS symptom score" or similar approaches. If researchers include extraneous symptoms or comfort perceptions, or exclude important symptoms from the definitions used in their analysis, their analysis will be less sensitive. It will be less likely to identify important associations between exposure and symptoms.

The associations in a health study will be stronger to the extent that the measurements of disease and actual causal exposures are accurate. Therefore, measuring environmental factors distant in space or time from the subject of the symptom questions or associated environmental conditions will reduce the sensitivity of the study. The more indirect or inaccurate the measurement of exposure, the less sensitive the analysis will be. For

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example, if specific VOCs actually cause headaches in office workers, researchers who include skin problems in an analysis for VOC effects would be less likely to find the actual cause and effect association. Furthermore, measuring total VOCs, or measuring average office levels rather than actual individual micro-environmental levels, or measuring the previous week would all lessen the likelihood of finding the association. Since we do not yet know exactly what exposures are related to what health outcomes, we must make educated guesses and construct preliminary case definitions based on hypothesized mechanisms. The better our guesses, the better the results of our study; it's how close we get to the actual disease mechanism that determines the success of our studies.

Now we find support for our views in a recent paper by Mark Mendell of NIOSH; some of the answers (and questions) are clearer.

Mendell's Paper

Mendell reported his findings at Indoor Air '93 and explained them in a paper published in the journal *Indoor Air*, (Vol. 3, No. 4, December 1993, pp. 227-236). Motivated by a desire to understand the conflicting findings from various indoor air studies, Mendell carefully selected 32 studies to include in his analysis. These studies were the most complete reports of relevant epidemiologic studies involving more than one building and were published between 1984 and December 1992.

In reviewing the 32 studies, he assessed findings on 37 different "risk factors" potentially related to worker symptoms. He used a number of approaches to evaluate and summarize the studies' findings on symptom/risk factor relationships.

Mendell's Analytical Approach

The approach used by Mendell consisted of three major parts. He cautioned us to explain clearly that his approach was neither perfect nor the only one that might be conceived. Nevertheless, we found his analysis interesting and valuable, since it represents a systematic effort to make some sense out of the various studies that have been reported. We summarize his paper here, but we encourage interested readers to study the full text in the *Indoor Air* journal.

First, he prepared a summary of each study's findings in a table. He listed whether each potential risk factor was associated with a statistically significant increase in symptom prevalence, a decrease in prevalence, or no significant change in symptoms at work (e.g., an increase or decrease of "*at least one* of the following symptoms: eye, nose, throat or skin symptoms; breathing or lower respiratory problems; fatigue or tiredness; or headache.").

Second, he evaluated the *consistency* of the findings for each factor across all the studies. He rated them as either consistent, mostly consistent, or too inconsistent or sparse for current interpretation. He found that a number of factors were, with at least general consistency, related to worker symptom prevalence.

Finally, he described study design features that minimize the potential for biased findings, and for each factor, evaluated the strength of each study design related to the findings for each factor and summarized the findings of the strongest studies. Only a small number of factors were found to be related to symptom prevalence in studies of strong design. Mendell summarizes in Table 3 the findings from individual studies reviewed, the consistency across studies of findings for each factor reviewed, and the studies considered to be of strong design. (Please see pages 4-5.)

Study Design Strength

Mendell evaluated the strength of each study in terms of key design features that could reduce potential bias relative to individual findings within the studies rather than to studies as a whole. For example, he considered a study that *manipulated* ventilation to assess relationships to symptoms while simply *measuring* temperature to determine its association with symptoms as stronger for assessing ventilation than for assessing temperature. For experimental studies, he considered designs strong which contained placebo or untreated groups. Mendell points out that blind designs may not be feasible for factors such as temperature.

For observational studies, Mendell considered those with either a case-control or follow-up study design to be stronger than the cross-sectional design, although he notes that the cross-sectional design "...is often the most practical approach in studying office worker symptoms..." He points out that cross-sectional studies underestimate effects if susceptible members of the population opt out of the workplace. The cross-sectional design also cannot tell us whether the exposure or the illness came first.

Findings from studies of strong design (summarized below in Table 1) are likely to be minimally biased, but such studies need replication. In some cases, such as with ionization, the actual effects produced may not have been directly from the intervention performed.

Table 1 - Findings from "strong study designs."

Factor	*Outcome*	*Number of Studies*
Low ventilation	Increased symptoms	1
Humidification	Decreased symptoms	1
Ionization	Decreased symptoms	1
Improved office cleaning	Decreased symptoms	2
Low ventilation rate	Unrelated to symptom frequency (an apparent inconsistency).	1

Overall Findings

Mendell found that a number of environmental factors were often associated with symptom-reporting frequency. He also found that there was either general consistency in the literature or that strong studies supported these associations. Among the most important of these were air conditioning, carpets, more workers in a space, VDT use, and ventilation rates at or below 10 liters per second per person (20 cfm/p). The results of his analysis are presented graphically in Table 3 on pages 4 - 5.

Consistency of Findings

He analyzed the consistency of the findings according to the criteria in Table 2. The results are summarized and labeled "Summary" in the last row of Table 3. The table indicates both the consistency of the findings and the impact on symptom prevalence.

Table 2 - Criteria used by Mendell to label consistency of findings.

Finding	*Definition*
Consistent	Agreement by all studies, no less than 3 studies.
Mostly consistent	One discordant study in four to six studies, or one or two discordant studies in seven or more studies, and so on (less than approximately 30%).
Inconsistent	Considered in more detail for some factors including ventilation rate.

Factors not in either of the above categories were considered to have data too inconsistent or sparse for complete evaluation. Some of these, including ventilation rate, were considered in more detail.

Mendell found that the SBS-symptom prevalence associations with the following factors and environmental measurements considered in the review fell into the following categories of consistency:

Consistent findings of higher symptom prevalence:

- Air conditioning systems (nine studies)
- Higher job stress/dissatisfaction (seven studies)
- Allergies/asthma (six studies)

Mostly consistent associations with higher symptoms:

- Carpets (five of six studies)
- More workers in the workspace (five of seven studies)
- Video display terminals (VDT) (six of eight)
- Female gender (12 of 13)

Findings for the following factors were so inconsistent as to include associations of higher and lower symptom prevalence:

- Humidity
- Noise
- Humidification
- Ionization

Mendell identified a number of factors for which the studies he reviewed had consistent or mostly consistent findings of no associations with altered symptom prevalence. These included total viable fungi, total viable bacteria, total particles, air velocity, carbon monoxide, formaldehyde, and noise. Mendell told the ***BULLETIN*** that negative findings – findings of no association – are far less persuasive than positive ones. The factors for which consistent findings of no association was found include several that are clearly capable of causing physiological effects. Few question whether formaldehyde, carbon monoxide, fungi, or particles are important risk factors. There are many reasons why studies may fail to find associations that actually exist. They probably do cause some SBS symptoms. Therefore, Mendell warns that we should not give too much importance to the lack of consistent findings of associations.

Table 3 - Summary of reported associations between work-related symptoms and various environmental factors and measurements, along with summary of key design features of studies reviewed.

STUDIES	STUDY FEATURES: Experimental comparison group	Blinded Experiment	Control for confounding	Objective health msmts.	Person-specific envir. msmts.	ENVIRONMENTAL MEASUREMENTS: Low ventilation rate	Carbon monoxide	Total VOCs	Formaldehyde	Total particles	Respirable particles	Floor dust (all or protein)	Total viable bacteria	Total viable fungi	Endotoxins	Beta-1,3-glucan	Low negative ions	High temperature	Low humidity	Air velocity	Light intensity or glare	Noise
EXPERIMENTAL																						
Jaakkola 90	$+^{C}$	$+^{2}$	+			◙																
Jaakkola 91	+	+	+			◒																
Leinster 90	+	$+^{2}$																				
Menzies 93	$+^{C}$	$+^{2}$	+			◙												◓		◓		
Raw 91	$+^{P}$	+																				
Reinikainen 92	$+^{C}$	(+)	+																◓			
Wyon 92	$+^{P}/+$	+/		+		◙											(◓)	◓	◓		◓	
Finnegan 87		$+^{2}$	+														(◓)					
Hawkins 84		$+^{2}$															(◓)	○	○			
Nagda 91		+				◓																
Norbäck 89																						
OBSERVATIONAL																						
Hedge 89			+																			
Hodgson 91			+		+	○	○	◓			○				○			○	○	○	◓	○
Hodgson 92			+		+	○	○	◓										○	○	○	○	◓
Jaakkola 91			+			○												◓				
Mendell 92			+			○	○	○					○	○				○				
Menzies 92			+	+	+									◙								
Norbäck 90			+			○		◓			◓							○	○			
Reinikainen 91			+																◓/◓			
Skov 89			+	(+)																		
Skov 90			+	(+)		○		○	○	○		◓	○	○				◓	○	○	○	◒
Skov 90a			+	(+)		○		○		○		○	○	○			○	◓	(◒)		○	○
Sundell 92			+			◓												○	○			
Zweers 92			+			○												○	○		○	○
Burge 90						○												○	○	○	○	○
Finnegan 87a																						
Harrison 92										○			○	◓								
Hill 92						○					◓											
Knave 85																						
Kroeling 88																						
Mendell 90																						
Robertson 89																					◓	
Rylander 92															◓	◓						
SUMMARY						↑	**O**	?	**O**	**O**	?	?	**O**	O	?	?	?	?	?	O	?	O

Table 3 - Continued.

STUDIES	BUILDING FACTORS: Air conditioning	Humidification	Mechanical vent'n, no a.c.	Newer building	Poor vent'n maintenance	WORKSPACE FACTORS: Ionization	Improved office cleaning	Carpets	Fleecy materials/open shelves	Photocopier in room or near	Environmental tobacco smoke	More workers in the space	JOB AND PERSONAL FACTORS: Clerical job	Carbonless copy use	Photocopier use	VDT use	Job stress/dissatisfaction	Female gender	Smoker	Allergies/asthma
EXPERIMENTAL																				
Jaakkola 90																				
Jaakkola 91																				
Leinster 90							◒ ■													
Menzies 93																◓		◓		◓
Raw 91							◒ ■													
Reinikainen 92		◒ ■																		
Wyon 92		◒				◒ ■														
Finnegan 87						◓														
Hawkins 84						◒														
Nagda 91																				
Norbäck 89								◓												
OBSERVATIONAL																				
Hedge 89	◓	◓											◓			◓	◓	◓		
Hodgson 91											○	◓				○		○	○	
Hodgson 92									○			○	○				◓	◓		
Jaakkola 91											◓						◓	◓		◓
Mendell 92	◓		◓					◓		○		◓	○	◓	◓	○	◓	◓	◓	◓
Menzies 92								◓								◓			◓	◓
Norbäck 90			○	○				◓									◓		◓	
Reinikainen 91		◓/◒																		
Skov 89							○					◓	◓	◓	◓	◓	◓	◓	◓	◓
Skov 90	◓		◓	◓			○	◓	◓			◓								
Skov 90a		(◓)					◒		○			○						◓		
Sundell 92			○						○	◓										
Zweers 92	◓	◓	◓					○	○		◓	◓		○		◓	◓	◓	○	◓
Burge 90					◓													◓		
Finnegan 87a	◓	◓																◓		
Harrison 92	◓	○																		
Hill 92																		◓		
Knave 85														○		◓		◓		
Kroeling 88	◓																			
Mendell 90	◓	○																		
Robertson 89	◓																			
Rylander 92																				
SUMMARY	↑↑	?	?	?	?	?	?	↑	?	?	?	↑	?	?	?	↑	↑↑	↑	?	↑↑

LEGEND

STUDY FEATURES

- + Yes
- +P Yes, placebo
- +C Yes, crossover
- +2 Yes, double blind
- ( ) Indirectly applicable

ASSOCIATIONS WITH FACTORS AND MEASUREMENTS

- ◓ Higher symptoms
- ○ No associations
- ◒ Lower symptoms
- (blank) Not assessed
- ( ) Indirectly applicable
- ■ Strong design

SUMMARY

- ↑↑ Consistent higher symptoms
- ↑ Mostly consistent higher symptoms
- **O** Consistent lack of association
- O Mostly consistent lack of association
- ? Sparse or inconsistent findings

Summary of Important Findings

The following are some of the factors most consistently found associated with increased symptom reporting frequency.

Environmental Factors:

- Air conditioning
- Carpets
- More workers in a space
- VDT use
- Ventilation rates ≤ 10 liters per second per person (L/s/p, or 20 cfm/p).

Personal Factors:

- Job stress/dissatisfaction
- Female gender
- Allergies/asthma

What Do the Results Mean?

Mendell has looked for consistency of findings among studies. But he tells us that he has not evaluated the quality of the measurements themselves, although he has noted the measurement of ventilation rates with tracer gas as more reliable than other methods. We regard this as an extremely important qualifier of Mendell's results. Our view is that poor measurement methodology is frequent. Furthermore, we do not believe that exposure measurements distant in time or space from the measured human response of concern are very reliable indicators of exposure. Lance Wallace has demonstrated the importance of personal activity-related sources of contaminants as the most significant indicator of individual exposure (1987).

Mendell does not speculate on the actual causes of the elevated symptoms. As an epidemiologist, he is appropriately cautious. But those involved in preventing or resolving problem buildings must make some guesses in order to inform their actions. It is common, for example, to assume that the lower the VOC concentrations, the less likely the symptoms. But this is only evident if the mixture of VOCs remains constant since any single compound could easily cause irritation or other adverse effects without significantly increasing the total VOC concentration.

It is not clear whether the factors themselves are causally related to the SBS symptom prevalence or whether they might co-vary with other factors. Even more difficult to discern would be a co-variance of several factors so that some but not all might be present in parts of a building or portion of a building being studied.

We can examine each of Mendell's findings of "consistent higher symptoms" and try to hypothesize some mechanisms that might explain the consistent findings. Reasonable hypotheses are not always obvious or easy. For example, it is not clear what it is about air-conditioning itself that might cause higher symptom prevalence.

Air Conditioning

Air-conditioning system complexity may frequently lead to poor operation or maintenance of the HVAC system. The exact nature of the failure may vary, but in general it appears that something results in various problems associated with higher symptom prevalence. James E. Woods, Jr., found that the majority of air-conditioning systems in complaint buildings he investigated suffered from inadequate maintenance, improper operation, or both. (Woods, 1988) It's possible that some air-conditioning systems cause various problems including microbial contamination, dirty filters or duct liners, and elevated particle levels from deteriorated duct liners caused by the moisture breakdown of binders, etc. Perhaps none of these factors alone shows up as a significant factor based on environmental measurements, but collectively they may increase symptom prevalence.

Carpets

Similarly, carpets themselves may not be the direct cause of increased symptoms. It may be that carpeted spaces are not cleaned as well as those with bare floors. The dust, microbial organisms, or chemicals that can occur in carpets may be more directly responsible for the higher symptom prevalence.

Interestingly, Thomas Schneider of Denmark and his co-workers found that carpets and bare floors require roughly the same amount of maintenance to control dust to the same levels (1993a). However, the larger, fleecy, fibrous surface of carpets might hide dirt; this could result in less perceived need for cleaning and less frequent vacuuming. The same fibrous surface also provides much greater area for adsorption of chemicals resulting in higher average airborne concentrations. Perhaps something that is rarely measured, such as semi-volatile organic compounds (SVOCs), is responsible for some of the increased symptom reporting in carpeted spaces. The carpet surfaces also may create micro-environments favorable to microbial growth. Perhaps the organisms that are likely to favor carpeted environments such as dust mites also cause some increased symptom reports.

More Workers in Space

Why would spaces with more workers have more SBS symptom reports? Activity-produced contaminants and infectious disease transmission (e.g., flu, tuberculosis) can easily contribute to elevated symptom rates. We have speculated previously that a combination of exposure, social, and psychological factors interact to produce more symptom reports in more densely occupied spaces or in spaces with more workers. (Levin, 1989) Such spaces are more likely populated by lower-status workers who have jobs involving more exposure to office products, materials, and machines emitting chemicals. Interior spaces often have poorer air distribution and less air exchange than perimeter spaces or private, individual offices.

Workers in more populated spaces are often less mobile than higher status workers; this results in more time at the job. Interior spaces are often assigned to lower status workers such as clerical personnel, while their supervisors enjoy locations at the perimeter, often with better access to windows and views. Workers in more populated spaces may feel an anonymity or lack of investment in the welfare of the organization as a whole. They may have less job security. All of these factors can result in increased symptoms reports.

VDT Use

VDT use can mean greater exposure to particulate matter. Schneider and co-workers reported that the deposition of particles in eyes and on facial skin of VDT users can be ten times that of those not using VDTs. (Schneider, 1993b) The cause is the electrostatic field created by the VDT. VDT use can also involve stressful postures, work-production rate requirements, or tedium, among other sources of stress. Thus, it is logical that VDT workers would experience more work-related symptoms.

Ventilation Rate and SBS Prevalence

A question of considerable interest to all concerned with IAQ and building environmental concerns is the impact of ventilation on SBS symptom prevalence. The assumption is that because concentrations of indoor source contaminants will decrease as outside air ventilation rates increase, symptoms should decrease as well.

When Richard Menzies and his co-workers from Canada published their contrary findings in the *New England Journal of Medicine* in 1993, their findings drew considerable press coverage. They reported that SBS symptoms did not decrease when ventilation increased from an estimated 30 cfm/p to an estimated 64 cfm/p. There has been much criticism of their study, some of which has been discussed in earlier issues of the ***BULLETIN***. The most fundamental criticism was that no one had previously reported elevated SBS symptom reports at ventilation rates in excess of 20 cfm/p. Therefore, the study was of little value in understanding the impact of increased ventilation on symptom prevalence. Due to some methodological problems, it is not clear exactly what ventilation rates were in the buildings that Menzies studied, but clearly they were higher than the rates of concern to most interested parties.

Figure 1 shows the results of Mendell's review of the ventilation rate/symptom relationships based on some re-calculation and estimates necessary to compare the studies he reviewed. The results shed some light on the ventilation/SBS symptom question and the findings of Menzies. Mendell's analysis showed no significant differences in symptom prevalence between spaces when both mean ventilation rates being compared were >10 L/s/p. There were mostly consistent findings of statistically significant differences in symptom prevalence between spaces when the mean ventilation rate in at least one space was at or below 10 L/s/p. The one exception was in the report of Jaakola *et. al.*, (1990).

Mendell asked us to alert our readers who receive the journal *Indoor Air* that there is a critical typographical error in the published article. The "Abstract" erroneously reads as follows: "Studies with particularly strong designs found decreased symptoms associated with <u>low</u> ventilation rate..." Mendell points out that the sentence should read <u>high</u> ventilation rate. This misprint will undoubtedly perplex some readers, Mendell said. Figure 1 shows the finding clearly.

Where "more accurate" ventilation rate measurements were made using tracer gas techniques, Mendell found they were more likely to find associations between symptoms and air exchange rates than studies that used air flow rates or carbon dioxide measurements as the bases for their ventilation rate estimates. Thus, it is possible that fairly widespread inaccuracy in the ventilation rate measurements themselves are resulting in inappropriate findings and conclusions in many studies.

"All negative studies used relatively less accurate methods for measuring ventilation rate (compared to tracer gas methods)..." This may have been exacerbated by the inability to measure variations in ventilation rate delivery throughout the building that might have obscured any effects that were present. Mendell also points out that comparing effects of ventilation across buildings without assessing differences in sources may also distort findings.

Job Stress/Dissatisfaction

As suggested above, it is not evident from the studies whether the symptoms cause the job stress and dissatisfaction or vice versa. It is plausible that the two interact and reinforce each other. It is likely that the greater the dissatisfaction, the more the individual might focus on the discomfort they experience at work. It is also plausible that the symptoms may contribute to and reinforce the job dissatisfaction. It is well-proven that psychological stress decreases the effectiveness of individuals' defenses against environmental stressors.

Female Gender

It is not clear to us whether this factor by itself co-varies with one or more other variables differently within and among office buildings. Certainly in most North American and European offices, males tend to have the higher status jobs and, presumably, the better office environments. It is also likely that women occupy jobs with more repetitive tasks and less personal freedom or control of the work or the environment. Any combination of these factors may explain the higher symptom prevalence in some situations.

Allergies/Asthma

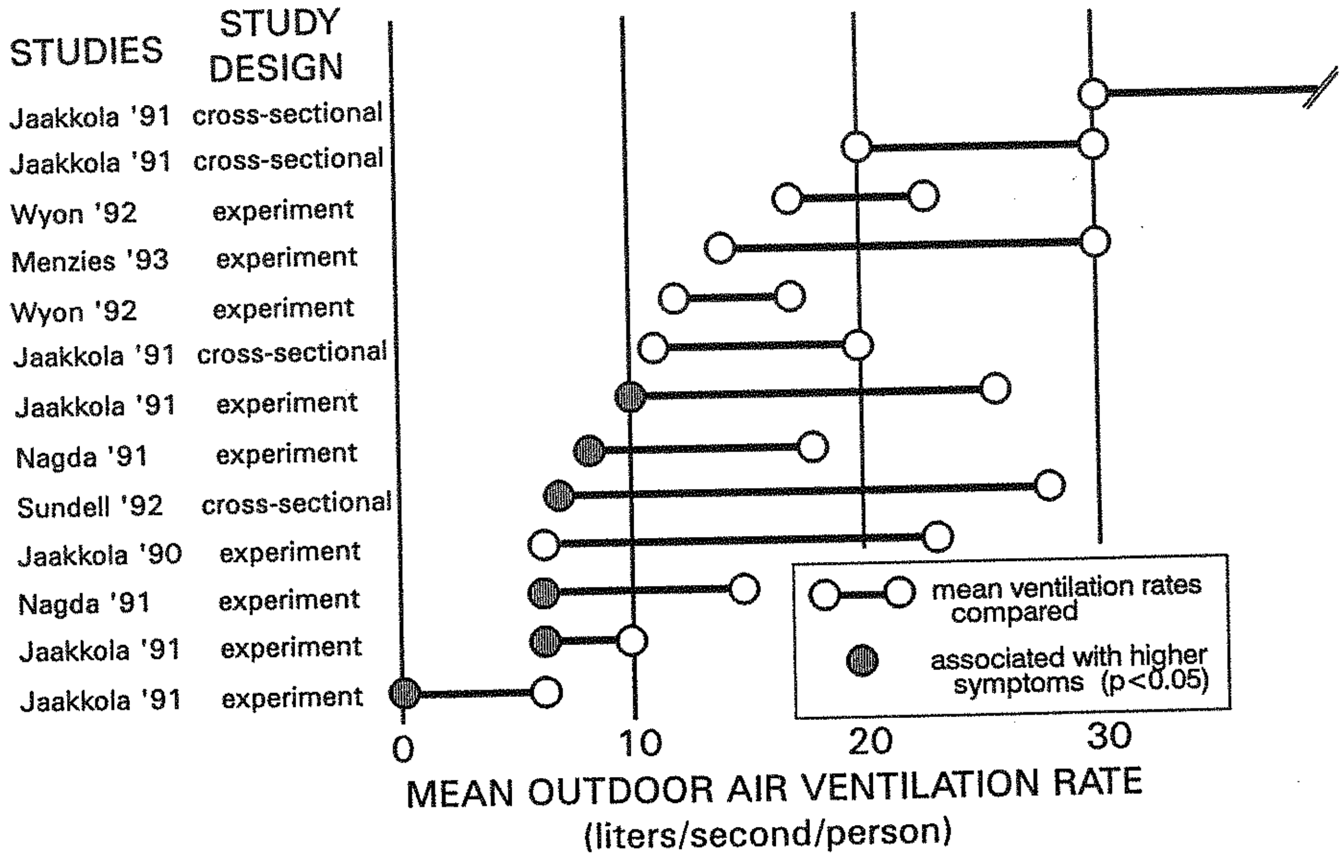
It seems too obvious to require discussion that allergic and asthmatic individuals would have more symptoms than other individuals in any environment. Allergic and asthmatic individuals are clearly more sensitive to a variety of environmental stressors including formaldehyde, VOCs, and allergens. Varying combinations of these may result in an overall increase in symptom reporting.

Mendell on SBS Study Methods

Mendell analyzed SBS studies in order to develop an overview of the findings in a systematic fashion. His report is very helpful in understanding the trends, consistencies, and conflicts among the studies. What does Mendell mean when he says "strong study design?" He discussed some of the factors that he considers important to interpreting the results from the studies. His discussion helps us gain some understanding of some significant variations among the research methods employed and of some of the potential sources of bias or confounding of results. He explains how bias "...either hides, exaggerates, or even falsely creates relationships... and, even in an otherwise excellent study can produce invalid and misleading findings."

He compares the benefits and drawbacks of observational versus experimental designs. He discusses the

Figure 1 - Outdoor air ventilation rates and work-related symptoms: reported relationships summarized using estimated mean ventilation rates compared.



difficulties inherent in experimental designs that makes them so rarely free from some source of bias. He also describes various types of observational studies, highlighting the cross-sectional studies that collect information of health and exposure simultaneously and the case-control studies that compare groups with varying levels of symptoms.

Mendell says that while the cross-sectional design is often the most practical way to study office worker symptoms, it may underestimate disease effects if the most susceptible individuals have left the workplace. It is also unable to assess whether stress or symptoms came first. He emphasizes that single-building case studies tend to be the least informative, saying that investigations of problem buildings in response to occupant complaints rarely provide "...scientifically useful findings due to their limited designs." To address the shortcomings he identified, Mendell says researchers can reduce bias in epidemiologic studies in three ways as shown in Table 4.

Mendell's Conclusions

Mendell reports that the studies he reviewed indicate that in normal (non-problem) buildings we can reduce the prevalence of some symptoms that "...represent preventable physiologic effects of environmental exposures or conditions in office buildings."

He concludes that the studies show that SBS is a multifactorial problem that may involve chemical, microbiological, physical, and psychological mechanisms. In fact, the syndrome "...may ...represent overlapping sets of symptoms involving multiple causes and physiologic pathways..." The role of psycho-social factors, although apparently important, is not clear. It may be that the symptoms induced stress or vice versa.

Table 4 - Strategies for minimizing bias in epidemiologic studies.

Strategies	*Comments/Techniques*
1. Techniques to control confounding	Multiple-regression modeling. Matching. Within-subject comparisons.
2. Objective health measurements	Less liable to be influenced by extraneous factors than subjective ones.
3. Person-specific environmental measurements	More likely to be accurate for each person than room-average measurements.
4. Selection of Populations	Select appropriate populations for the comparison of interest.

In the end, he says, more studies are needed with strong designs. We think his results show that double-blinded intervention studies are the most likely to produce useful, reliable results. His conclusions support our view that measurements of both environmental exposures and health outcomes should be improved. He identifies several "promising targets" for future studies including temperature and relative humidity, (Berglund and Cain, 1989) VOC, (Mølhave, 1991) and "particularly microbiologic materials" (Miller, 1992; Platt *et. al.*, 1989; Jaakola *et. al.*, 1990a). His overall conclusion about what we can do now? "Until we can identify ...specific causes, appropriate mitigation and prevention of building-related symptoms may need to be at the level of prudent design, operation, and maintenance practices, focused on factors which reduce the *likelihood* of problem indoor exposures and conditions."

Acknowledgments

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Jury Awards $950,000 in EPA Headquarters Building Lawsuit

A Washington DC jury recently awarded a reported $950,000 to five of nineteen plaintiffs who sued the owner-operator of the Environmental Protection Agency headquarters building where they worked. The jury reportedly found that the plaintiffs believed the building damaged their health; however, the jury did not find that the building environment caused the health harm that the plaintiffs claimed. In making the monetary award to the plaintiffs, the jury presumably found negligence or other liability on the part of the defendant, the building owner/operator. The court has not yet tried the cases of the other fourteen plaintiffs.

The $950,000 award is a landmark IAQ event in the US. We know of no previous jury award in any similar case involving sick building syndrome (SBS), building-related illness (BRI), and multiple chemical sensitivity (MCS). Many individuals have filed lawsuits involving known, specific hazards such as asbestos, formaldehyde, or pesticides. In these lawsuits, plaintiffs have successfully shown direct damage to building occupants' health. There have reportedly been settlements for high six-figure dollar amounts. But this is the first case where a general, "multifactorial" causal theory has resulted in a substantial jury award.

This case may have a significant impact on everyone concerned with IAQ and many others who have not been concerned previously. Certainly, insurance carriers for building owners, designers, builders, operators, as well as materials, equipment, and furnishings manufacturers will take notice. The possibility of jury decisions favorable to plaintiffs can only encourage more building IAQ lawsuits.

Curiously, there has been almost no publicity surrounding this jury award, and we've had difficulty obtaining Information on the case. Several attorneys and others we know who follow these things knew nothing about the decision. We spoke to several individuals involved in the lawsuit, and none of them could give a very complete or detailed account. Plaintiffs' attorneys did not return our phone calls.

The "Waterside Mall" Lawsuit

Nineteen workers sued the owner of the building leased by the federal government for the EPA. The building, at Waterside Mall in southwest Washington DC, has been EPA's home since its inception more than twenty years ago. Since the early 1980s and especially since early 1988, the building has been the subject of much publicity related to IAQ concerns. In the winter and spring of 1988, many occupants reported health problems following the installation of new carpet in portions of the building. Activists among EPA employees picketed the building, appeared at congressional hearings, and were featured in national radio and television programs. Some of these same individuals are among the plaintiffs in this lawsuit. More than thirty of EPA's workers at Waterside Mall moved out of the building to alternative workspaces, and some now work at home.

EPA and NIOSH studied the building extensively at a reported cost of more than a million dollars. The study included occupant questionnaires and environmental measurements, but did not provide a clear link between environmental parameters and the reported symptoms. (The four-volume study reports are referenced below.) The SBS symptom prevalence in Waterside Mall was high, but it was not apparently higher than in two other EPA buildings also surveyed during the study. Some Waterside Mall occupants charged that building operators reduced the concentrations of indoor air pollutants during the study by increasing the ventilation. We have never found the Waterside Mall environment particularly good, but our subjective experience, like most other people's, is not clearly supported by the expensive study.

The Trial

As we've said, specific information about the trial has been hard to get. The judge apparently required the plaintiffs to prove liability prior to showing health harm. The judge also decided to try the cases of five plaintiffs at once rather than one at a time, all at once, or any other combination. Each side reportedly chose two plaintiffs and both sides were to agree on the fifth one.

Reportedly, the plaintiffs' attorneys hesitated to bring at least one of the individuals they selected into court because of concern that further health harm would follow extensive exposure to the courthouse environment. This, our source said, surely diminished the effectiveness of the case. The source opined that the plaintiffs' attorneys had not presented the case as effectively as it could have been.

Hard to Say Who Won

The plaintiffs can claim a moral victory, but they apparently lamented the small award – after attorneys' fees, the five were not expecting to receive much compensation. Some believe the plaintiffs' attorneys did not have adequatè opportunities to prove the health damage claims. However, they say that the building environment was found deficient enough to cause the health harm they claimed to have suffered. And, presumably, the jury found the building owner/operator responsible.

BULLETIN sources said the defense attorneys have claimed victory saying that the amount of the jury award was insufficient to even pay the plaintiffs' legal costs. Furthermore, other sources told us that the plaintiffs did not rebut the testimony of a key defense witness, Dr. Abba Terr, widely know for his writing and testimony discrediting MCS as a medically valid diagnosis. He has published papers claiming to show that individuals who believe they have MCS in fact have psychiatric or other disorders.

Still to Come

Fourteen plaintiffs remain whose cases have not been tried. We have not heard whether these cases will be tried or a settlement negotiated. Both sides have a far better understanding of what they face and what it will cost to pursue the remaining cases; under those circumstances, settlement is more likely. Any monetary award greater than what has been awarded to the first five plaintiffs would likely be consumed by additional legal costs. Defense costs would likewise continue to rise, and those costs are likely to be considered by the defendants in negotiating any settlements.

The plaintiffs' qualified success may still encourage other Waterside Mall occupants to file lawsuits. The factual basis for the suit is now a matter of court record, so the preparation of additional, similar suits would presumably be more economical. The remaining plaintiffs in the existing suit and any new ones also have the benefit of knowing the defense strategy and arguments, thus enabling them to prepare and argue a more effective complaint.

In other lawsuits involving SBS or building-related illness (BRI), there are usually many more defendants: contractors, designers, building materials manufacturers, and even IAQ or other consultants. Many of these defendants settle in order to be dismissed from the suit. The amounts of the settlements can be substantial – frequently amounting to tens or hundreds of thousands of dollars. The plaintiffs' attorneys then use the proceeds from the settlements to finance the preparation of the case for trial.

Another consideration is that plaintiffs' attorneys often work on a contingency basis: they receive an agreed portion of the award or settlement moneys. They will be encouraged by the news of a jury award, albeit small. One of the great unknowns in suits involving IAQ problems is how juries will react; there have been so few relevant cases actually tried in court. Even less well known is how the court's rulings might stand up under an appeal.

Defense attorneys often work for insurance companies or, occasionally, directly for defendants. The various defendants often have more to lose by negative publicity surrounding the lawsuit than by the actual monetary cost of any settlement or potential jury award. When a case involves highly visible plaintiffs, defendants, or buildings, the press is more likely to report the progress of a lawsuit. Publicity involving such a lawsuit can almost never help defendants and will usually have negative impact on a defendant's reputation and standing in the community. Such damage is difficult to repair, as the former Johns Manville company found out; JM ultimately changed its name. The name change was just one of a number of actions apparently intended to erase the effects of the many, well-publicized lawsuits involving asbestos products previously manufactured by Manville and others.

References:

EPA, Indoor Air Quality and Work Environment Study, Vol. 1, November 1989; Vol. 2, May 1990; Supplement to Vol. 2, May 1990; Vol. 3, March 1991 (21M-3002); Vol. 4, June 1991 (21M-3004). Washington DC, Office of Administration and Resource Management.

Letters

Cole on Marcinowski

Dear Hal:

A letter to the ***BULLETIN*** (Vol. 3, No. 1) from EPA Spokesman Frank Marcinowski alleges that my book, *Element of Risk: The Politics of Radon*, "perpetuates ... misconceptions about radon policy and science." Your response to his letter in the same issue of the ***BULLETIN*** points out the transparency of his allegations. But your readers might be interested to see how mistaken his actual words were.

Marcinowski writes that my "main premise... is that EPA policy and science does [sic] not represent mainstream knowledge." Wrong. My main premise is that the public deserves to be given the full range of scientific information about radon. This includes uncertainties about the health effects of exposure at low concentrations, which EPA virtually ignores in its communications to the public.

Marcinowski says: "Another example of an improper characterization of EPA's position occurs when Cole indicates EPA data implies [sic] 30% of US homes are above the action level of 4 pCi/L." Nowhere do I make such a statement and Marcinowski's claim that I do is patently false. I do quote an EPA official regarding a proposed law that would designate "priority radon areas." The designation would apply to regions where indoor radon generally exceeds 1.3 pCi/L. This would mean according to the EPA official, "one-third of the country would be considered high risk" (Element of Risk: The Politics of Radon [Washington, DC: AAAS Press, 1993], page 100).

Marcinowski writes: "Another example of Cole's bias is his characterization of EPA's action level of 4 pCi/L as being inconsistent with a number of other [sic] European Countries." Some European countries have established action levels, but none as low as that in the U.S. Moreover, in no other country has there been anything like the alarmist public communications campaign that the EPA has conducted here.

I did find one new piece of information in Marcinowski's letter. In 1991 Richard Guimond, director of radiation safety programs in the EPA, said that the agency's radon program would cost Americans $8 billion (Conference on "Radon Today: The Science and the Politics," sponsored by the U.S. Department of Energy in Bethesda, MD, April 25-26, 1991). now Marcinowski says the program would cost $45 billion. He does not tell us what the EPA discovered during the past two years to raise the estimate nearly 6-fold.

Although prolonged exposure to high radon concentrations is known to increase the risk of lung cancer, epidemiological studies thus far have failed to confirm a risk from low concentrations. I agree with scientists who think that high indoor levels should be lowered. A sensible national policy would aim at locating and remediating houses where radon concentrations exceed 20 pCi/L (See, for example, Anthony V. Nero, Jr., "A National Strategy for Indoor Radon," Issues in Science and Technology, Vol. 9 No. 1 [Fall 1993]. The overall cost might then be measured in millions of dollars rather than the billions built into present policy.

Until low radon levels are shown to be hazardous, an official policy that urges universal testing, and mitigating already low levels, is unwarranted. Of course, a citizen ought not be discouraged from properly testing his home for radon if he wished. Nor should he be impeded from trying to reduce low levels even further. But his decisions should be taken with an understanding of the uncertainties about the harm, if any, of low levels of the gas.

It should be the responsibility of regulatory officials to provide the full range of information, not skew it as the EPA has done. The right of citizens to make informed choices is central in a democracy. It is also a central theme of my book.

Sincerely,
Leonard A. Cole, Faculty Associate, Program in Science, Technology, and Society, Rutgers University

Note: We reviewed Cole's book in Vol. 2, No. 12, and published Marcinowski's letter in Vol. 3, No. 1 of the ***BULLETIN***. The book, published by AAAS Press, is available from Tasco, $29.95/copy + $4.00 shipping and handling, 301 645-5643, fax 301 843 0159.

Correction to Marcinowski's Radon Letter

We deleted an important hyphen in the letter from Frank Marcinowski (EPA Radon Division) in Vol. 3, No. 1. At the top of page 12, we erroneously printed that certain European countries "...recommended action levels in the 310 pCi/L range." In fact, the recommended action levels are in the 3 - 10 pCi/L range. We apologize for any confusion we might have caused.

Thermal Comfort and Radon

Dear Mr. Levin,

On page ten of Vol. 3, No. 1, ***Indoor Air BULLETIN***, I question the order of thermal comfort parameters listed in "Thermal Comfort is Complex". In an address to a symposium at the National Bureau of Standards in 1977, P.O. Fanger, a respected leader in the field of comfort, reviewed the importance of these rankings. He rated them in the following order, air temperature, air velocity, radiant temperature, and then vapor pressure (relative humidity).[1] In addition he mentioned that below 72 °F the importance of vapor pressure is insignificant. I am concerned that relative humidity has been given too much undeserved importance in numerous articles, some of which may be due to its inadvertently having been listed second rather than fourth. Other than Fanger's, I have seen no other credible ranking which would put relative humidity higher on the list.

I am also interested in the "Letters" concerning the EPA Radon Policy. If anyone were truly interested in decreasing potential radon problems I believe that the subject of cellar storm sewer drains in basements of houses should be addressed. Cellars with floor drains which do not have traps allow free passage of outdoor air to enter buildings. To my knowledge, cellars with these drains are common in cities from Washington, D.C. to the east including many in New York State. I have seen little mention of this problem.

I am interested in your thoughts on these.

Sincerely,
Kevin M. Kelly

1 U.S. Dept. of Commerce, Thermal Analysis--Human Comfort--Indoor Environment by P.O. Fanger, Ed. by B. W. Magnum, J. E. Hill, National Bureau of Standards SP491, Washington DC 1977, pp. 3-17.

The *BULLETIN* Replies

The order in which we listed the parameters was not intended to indicate their relative importance. In the context of thermal comfort determinations, the actual importance is part of a set of the complex inter-relationships that affect thermal self-regulation by the body. The relative contributions of the various factors are quantified in the equations used to determine thermal comfort in Chapter 8, "Physiological Principles and Thermal Comfort," in the *1993 ASHRAE Handbook, Fundamentals*. Note that the units used determine the apparent mathematical importance of each factor, and selection of Kelvin or absolute temperatures or different units to express water vapor pressure would alter the apparent relative numerical importance. Additional technical information on thermal comfort is available in two similar thermal comfort standards (ASHRAE Standard 55-1992 and ISO Standard 7730) derived largely from the work of Fanger, Rohles, Nevins, Gagge, and others.

The importance of relative humidity stressed in many recent publications relates not only to thermal comfort but also to potential impacts on SBS symptoms and to the impacts of water vapor on microbial growth on building materials and furnishings. Jan Sundell and Thomas Lindvall of Sweden have just reported a study of nearly 5,000 office workers to determine the impacts of air humidity and sensations of dryness as risk indicators for SBS. They found no association between measured air humidity and SBS symptoms or the sensation of dryness. They did find that the sensation of dryness "is an important indicator of an indoor environment that provokes SBS symptom reports."

Water activity at surfaces of materials governs the growth of microbial organisms in indoor environments. Such growth can produce higher concentrations of odorous, irritating, or toxic chemicals and of infectious agents such as bacteria and viruses. Water activity at surfaces is a function of the characteristics of the materials and of the indoor air humidity. See the papers of Phil Morey, Brian Flanigan, David Miller, Harriet Burge, Aino Nevalainen, and many others in recent ASHRAE publications, and in the *Proceedings of Indoor Air '93*.

We agree regarding the importance of cellar drains to potential radon entry. However, it is not outdoor air but rather soil gas that conveys the radon gas resulting in severely elevated radon concentrations. The stack effect in many structures negatively pressurizes the lowest level relative to the rest of the structure. Where that lowest level is a basement, every potential path for soil gas entry should be carefully addressed, not just to prevent radon entry but also other potentially harmful soil gases such as pesticides or decomposition products from organic wastes.

Indoor Air and Human Health Revisited

The question of human health effects resides at the core of most IAQ concerns. Yet few programs or publications directly address the many issues and unknowns. "Indoor Air and Human Health Revisited" is planned to focus on what we know and don't know about the impacts of indoor air on health. Invited speakers will discuss human sensory responses, allergy, respiratory disease, neurotoxicity, and cancer. A flyer enclosed with this issue of the ***BULLETIN*** contains a complete schedule of speakers and topics.

The scheduled speakers include many of the individuals on the forefront of research on the health effects of indoor air exposure. The symposium is likely to produce a state-of the-art review publication on the subject with a strong emphasis on, but not exclusively reflecting, US points of view.

The "Revisited" in the symposium's title refers to a previous symposium on the same topic held October 29-31, 1984. As is intended with the coming event, the 1984 symposium resulted in the publication of a book, *Indoor Air and Human Health* (referenced below). The planned symposium is chaired by Dr. Richard B. Gammage of Oak Ridge National Laboratory who, along with Stephen V. Kaye, also of ORNL, chaired the previous one and edited the book.

If you are interested in attending the symposium, contact Dr. Gammage at ORNL, 615 574-6526.

Calendar of IAQ Events

February 16-17, 1993. **Green Building Conference**, National Institute of Standards and Technology (NIST), Gaithersburg, MD. Sponsored by NIST and The U. S. Green Buildings Council. For registration, contact Ms. Lori Phillips, A903 Administration Bldg., NIST, Gaithersburg, MD 20899, 301 975-4513. For technical information, contact Hunter Fanney, 301 975-2767.

February 22-23, 1994. **Indoor Air Quality for Facility Managers**, San Diego, California, Sponsored by International Facility Manager's Association (IFMA). Contact: IFMA, 1 East Greenway Plaza, 11th Floor, Houston, TX 77046-0194, 800 359-4362, fax 713 623-6124. *BULLETIN Editor Hal Levin is the instructor.*

March 14-16, 1994. **7th Annual National Conference on Indoor Air Pollution**, Tulsa Oklahoma, sponsored by the University of Tulsa. Contact: Univ. of Tulsa, Division of Continuing Education, 600 South College Avenue, Tulsa, OK 74104-3189, 918 631-3008, fax 918 631-2154. *Conference fees: $395 ($345 before February 18), $295 per person "group discount."*

March 28-31, 1994. **Indoor Air and Human Health Revisited**, Eleventh ORNL Life Sciences Symposium, Knoxville, Tennessee. Contact: Conference Secretary, Oak Ridge National Laboratory, P. O. Box 2008, Oak Ridge, TN 37831-6383, 615 574-6829, fax 615 574-1778. *Symposium fee including proceedings and all functions is a reasonable $200.*

March 31 - April 1, 1994. **Florida Indoor Air Seminar**, Clarion Plaza Hotel, Orlando, sponsored by EPA and HRS Toxicology and Hazard Assessment. Contact HRS, 1317 Winewood Blvd., Tallahassee, FL 342399-0700, 904 488-3385, fax 904 921-0298. *Registration: $50.*

April 11-13, 1994. **ASTM Subcommittee D22.05 on Indoor Air**, Queen Elizabeth Hotel, Montreal, Canada. Contact George Luciw, Staff Manager, ASTM, 1916 Race Street, Philadelphia, PA 19103, 215 299-5571, fax 215 299-2630. *Standards for assessing Legionella outbreaks, for measuring VOC emissions from carpets and from caulks and sealants, and for determining the ETS contribution to RSP; and a variety of other standards are now under development. There will be a one-day workshop on Monday, before the regular meeting begins on Tuesday morning, for discussion of new developments in emissions testing and for discussion of methods for quantifying total volatile organic compounds (TVOC). ASTM committee meetings are open to non-members, and there is no charge for attendance. Membership in ASTM is only $50 per year, and members receive a copy of a volume of their choice from the Annual Book of Standards.*

April 12-14, 1994. **28th International Particleboard/Composite Materials Symposium**, Washington State University, Pullman, Washington. Contact: Conferences and Institutes, 208 Van Doren Hall, WSU, Pullman, WA 99164-5222, 800 942-4978 or 509 335-3530, fax 509 335-0945. *Registration is $385. Many of the scheduled papers are by industrial and scientific leaders in Europe.*

May 5-7, 1994. **Indoor Air Quality: Shaping the Industry**, 2nd Annual IAQ Conference & Exposition, Tampa, Convention Center, Tampa, Florida, Sponsored by National Coalition on Indoor Air Quality. Contact NCIAQ, 1518 K Street N.W., Washington, DC 20005, 202 628-5336, fax 202 638-4833.

May 21-27, 1994, **American Industrial Hygiene Conference and Exposition**, Anaheim, California. Sponsored by American Industrial Hygiene Association and the American Conference of Governmental Industrial Hygienists. Contact: AIHCE, 2700 Prosperity Avenue, Suite 250, Fairfax, VA 22031, 703 849-8888, fax 703 207-3561. *Sunday, May 22 there will be an all-day symposium on IAQ and standards.*

June 25-29, **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. *A call for papers has been issued. Abstracts must be submitted by mail (no fax submittals) in 11- or 12-point type within a 4.75 x 6.5 inch (10 cm x 17 cm) box. For details, contact Irva Hertz-Piccioto, Department of Epidemiology, Univ. of North Carolina, McGavran-Greenberg Hall, CB# 7400, Chapel Hill, NC 27599-7400. Abstracts must be received by March 1, 1994.*

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.

International Events

March 15 - 18, 1994. **Cold Climate HVAC '94** - International Conference on HVAC in Cold Climates, city of Rovaniemi, Finland. Sponsored by FINVAC, Federation of Societies of Heating, Air Conditioning and Sanitary Engineers in Finland. Contact: FINVAC/Cold Climate HVAC '94, Mr. Ilpo Nousiainen, Sitratori 5, SF-00420 Helsinki, Finland, +358-0-563-3600, fax +358-0-566-5093.

April 17-19, 1994. **International Symposium on Volatile Organic Compounds in the Environment**, Montreal, Quebec, Canada. Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate. Contact symposium chair Dr. Wuncheng Wang, U.S. Geological Survey, WRD, P. O Box 1230, Iowa City, IA 52244, 319 337-4191, fax 319 354-0510.

May 10-12, 1994. **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. *A Call for Papers has been issued; it requests 400-500 word abstracts prior to June 1, 1994.*

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 László 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 first announcement and Call for Papers has been issued. "Preliminary Abstracts" are due by January 31, 1994. 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. *Abstracts of no more than 20 lines must reach the Secretariat by February 28, 1994. Registration fee is 500,000 Lira before April 30, 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. *Abstracts of 300 words, single-spaced, are due March 31. Send Abstracts to Dr. Lidia Morawska, School of Physics, Queensland University of Technology, GPO Box 2434, Brisbane Qld 4001, Australia.*

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. *A Call for Papers has been issued; it requests 400-500 word abstracts prior to June 1, 1994.*

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