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Swedish Researcher Attacks SBS Head On

We may not know exactly what causes SBS symptom complaint rates to rise in problem buildings; however, perhaps we can still reduce them with practical, cost-effective methods. This is the notion put forward by researcher David P. Wyon of the Swedish Building Research Institute. Wyon's report of a study he conducted in a southern Swedish hospital appeared in *Environmental Technology* earlier this year. (See the reference at the end of this article.) The report is quite convincing. Titled "Sick Buildings and the Experimental Approach," the report is one of the most interesting SBS studies we've seen in some time.

Background

More than 25% of over 1,000 workers at Malmö General Hospital had registered complaints of SBS symptoms through Sweden's formal industrial injury complaint registration procedure. Investigators thoroughly inspected the building and found the ventilation system operating according to specifications, filters changed on schedule, clean ducts, and all rooms equipped and furnished according to the design. But the complaints led to a press campaign and the surgical wing was labeled a "sick building."

All of the complaints were of SBS-type symptoms. Yet the hospital was designed and operated to "a very high standard," and Wyon says that measuring every available physical parameter was unlikely to identify the causative factors.

Hospital staff felt that humidifying and ionizing the air would alleviate their symptoms. Wyon believed in advance that humidification might help but felt that the risk of causing problems was as great as the likelihood of alleviating them. He knew of other studies where improperly operated humidification systems were associated with elevated SBS complaint rates. While agreeing that humidification might reduce complaints of dry air, he suggested that a slight temperature reduction might have the same effect. (See ***IAB*** Vol. 2, No. 1, p. 4.)Besides, Wyon says, humidification consumes considerable energy and is expensive to install and run.

According to Wyon, ionization is a well-established technique in southern and eastern Europe. However, there are no published studies of *positive* effects on man except in asthma therapy, to treat burns, and to reduce airborne infection. Advocates of negative air ionization will disagree; they feel its benefits are significant. All of the positive effects, Wyon says, could be adequately explained by the rapid deposition of particles on oppositely charged surfaces: the ionization simply removes particles from the air. Unless respirable dust and certain types of electrostatic fields are found near subjects, more speculative explanations of the effective ionization mechanism are unnecessary, according to Wyon.

The Experiments

Authorities set up well-controlled field trials of how humidification, ionization, and seven other environmental measures affected SBS complaints. The object was to evaluate the measures against SBS symptom intensity and frequency. The results, described later, were surprising even to Wyon.

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There were four overall goals for the studies:

- To determine if available objective measures of SBS symptom intensity would co-vary with subjective symptoms.
- To discriminate between effects caused by expectation and effects caused by actual impacts on the physical environment.
- To exclude effects from external factors such as weather, epidemics, season, public debate, or press campaigns.
- To find simple ways to identify effective mitigation measures in complaint-ridden buildings.

Wyon emphasizes that these goals were stated at the outset as being more important than discovering the underlying causes or identifying any particular "air pollutants presumed to be causing the problems." He says that 20 years of worldwide research directed toward identifying specific SBS causes had failed.

The researchers tried the nine different mitigation strategies for periods of three weeks each during the heating seasons of 1988-89 and 1989-90. They evaluated the effects of the measures in terms of the impacts on SBS symptom intensity and frequency of occurrence. They used well-defined mitigation procedures, placebos, and reference wards to evaluate the impact of the mitigation methods and to study other research questions of interest. The nine experimental conditions are described in Table 1.

Condition	Period	Description
1. Low air flow	11/21/88-12/11/88	70% of normal airflow
Reference	Same weeks	Normal airflow
2. High air flow	1/30/88-2/19/89	140% of normal air flow
Reference	Same weeks	Normal airflow
3. Air cleaners	2/20/89-3/12/89	Free-standing air cleaners
Reference	Same weeks	No air cleaners
Placebo	Same weeks	Simulated air cleaners
4. New cleaning routines	1/9/89-1/29/89	Reduced use of chemicals
Reference	Same weeks	Normal cleaning
5. Low temps	1/9/89-1/29/89	1.5°C lower room T
6. Anti-static measures	2/27/89-3/19/89	Clothing, surfaces treated
Reference	Same weeks	Normal clothing, etc.
Placebo	Same weeks	Simulated measures
7. Reduced glare	1/15/90-2/4/90	Modified light fittings
Reference	Same weeks	Normal lighting
8. Air ionization	1/22/90-2/11/90	Ionizers in operation
Reference	Same weeks	No ionizers installed
Placebo	Same weeks	Ionizers disabled
9. Humidification	2/12/90 - 3/4/90	Steam humid. +15%RH
Reference	Same weeks	No humidification

Table 1 - Experimental Conditions, Timing, and Description.

Co-variability of Symptoms and Signs

The researchers also tried to find out whether subjective symptom intensities varied together with objective measures of SBS symptoms. For example, the investigators evaluated dryness of mouth by measuring saliva quantity and the time taken to swallow a vitamin tablet presented unexpectedly. They measured dry lips by observing lip moisture and by the subjects' reported use of lip salve during the same day. They measured break-up time (BUT) for tear film on the subjects' eyes to determine the association with eye discomfort. (BUT indicates physical changes in the tear film that are plausible precursors or concomitants of eye irritation.)

They compared reported aspirin use with reported headaches and feelings of "heaviness in the head." Wyon comments that the expression "heavy in the head" is "a common Swedish expression distinguishable from a true headache." [When asked why the Danes seem to report "heavy headedness" in their SBS studies whereas Europeans from more southerly countries do not, Danish researcher Lars Mølhave replied: "It's from our Viking helmets."]

Results

Overall, the researchers found humidification and ionization to be most effective of the eight experimental conditions evaluated in terms of their measurable effect on SBS. (Air cleaning was not evaluated because the experimental conditions did not produce measurable differences in airborne particle concentrations. The devices were deemed too noisy when operated as intended, so the flows were reduced to produce less noise. The result was that no real air cleaning was obtained due to the very low air flow rates.) Wyon stresses that the results were unexpected and he urges caution in interpreting them. He believes the findings must be confirmed in longer follow-up studies.

The changes in SBS symptom intensity and frequency resulting from the nine environmental interventions are shown in Table 2.

Negative Ion Generators Show Clear, Positive Effects

Wyon found a beneficial effect from using negative ion generators plus a small, positively charged external panel maintained at a nominal 8,000 volts. Using negative ionization together with positively charged anodes had a

	Condition	Results
1.	Low air flow Reference	Not significant
2.	High air flow Reference	Not significant
3.	Air cleaners Reference Placebo	Not significant; experiment not run as planned; only a negligible difference between experimental and reference wards.
4.	New cleaning routines Reference	Not significant
5.	Low temperatures	Positive (P<0.02)
6.	Anti-static measures Reference Placebo	Not significant
7.	Reduced glare Reference	Positive (P<0.02)
8.	Air ionization Reference Placebo	Beneficial (P<0.02)
9.	Humidification Reference	Reduced symptom severity (P<0.01)

Table 2 - Summary Results from Experimental Conditions.

"highly significant and beneficial effect on SBS-symptoms ($p<0.002$) in comparison with the placebo condition.... The effects were numerous, large, and statistically significant, and no negative effects of ionization were observed." Concurrently measured SBS symptoms in reference wards "...did not differ from those measured at other times in other reference wards."

The measured negative ion concentration was 26,000/cm^3 in the experimental ward and 60/cm^3 in the reference and placebo wards. The corresponding positive ion concentrations were 0/cm^3 and 160/cm^3 respectively. We believe it important to stress that the negative ion generators were used in conjunction with positively charged anodes (8kV), not alone as is often the case. This means that the charged particles created by the negative ion generators were removed by the anodes, not simply allowed to "plate out" on any available surface.

Figure 1 shows the responses to the ionization compared to the placebo condition. Clearly the ionization had a positive effect on nearly all symptoms. In 12 experimental and placebo wards with a total of 339 subjects, using the ionization system was positively associated with reduced SBS symptom rates. (The distance of each data point above the diagonal shows the magnitude of the positive effect in the ionization situation compared to the placebo condition.)

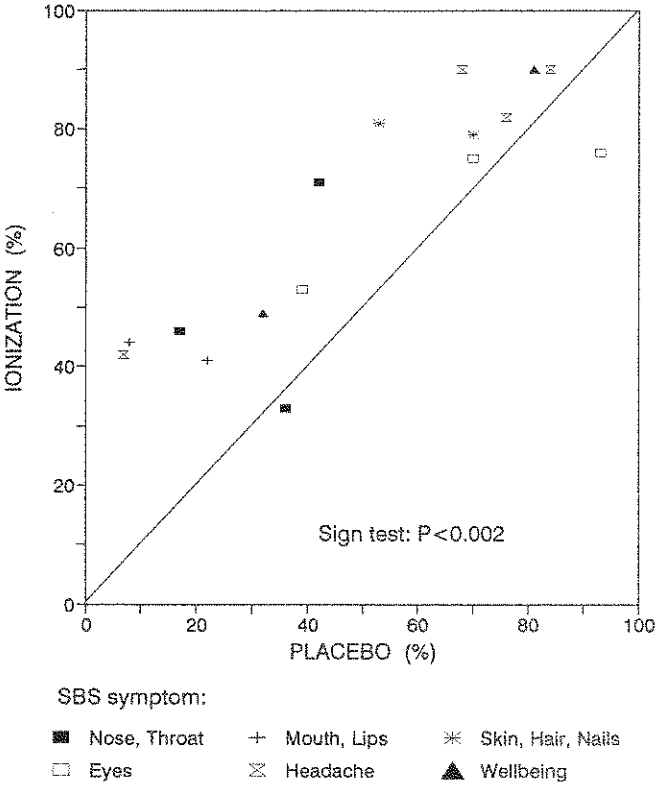

Figure 1 - Percent Responding Positively to Ionization.

To visually confirm the particle removal action of the ionization system, researchers placed filter paper on the positively charged panels. They observed that these rapidly became discolored although changed frequently. Investigators and building operators can use this method as a convenient, qualitative examination of particle loading in a space when using ionization/positive charge collectors.

Increased Humidity Decreases Symptoms

The experiments were all done during the winter; it should be no surprise that increasing humidity from 25% to 40% reduced the severity of symptoms ($p<0.001$). However, Wyon points out, not all of the observed effects were positive; "...the staff reported significantly more subjectively experienced 'stress.'" Figure 2 shows the results of the humidification experiment (40% RH compared with 25% RH in the reference wards).

Associations Between Objective and Subjective Measures

To determine the relationship between subjectively reported symptoms and objective signs, researchers observed both experimental and reference wards. They examined a total of 222 subjects in the eight reference wards. Table 3 shows the results.

The researchers examined 339 subjects in the 12 experimental and placebo wards to determine whether

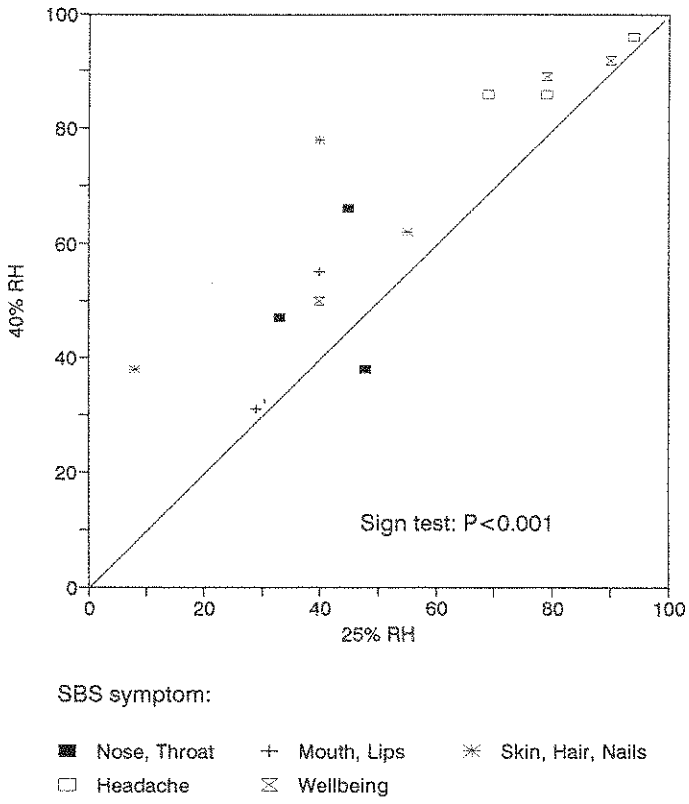

Figure 2 - Percent Responding Positively to Humidification.

SBS Symptom	Objective Evidence in Reference and Placebo Wards
Dryness of the mouth	Reduced saliva quantity ($p<0.02$)
	More time to swallow vitamin pill ($p<0.001$)
Dry lips	Observed dry lips ($p<0.001$)
	Reported use of lip salve ($p<0.01$)
Eye discomfort	Reduced tear film BUT* ($p<0.05$)
Headache	More reported use of aspirin ($p<0.001$)
Heavy headedness	More reported use of aspirin ($p<0.05$)

* Break-up Time

Table 3 - Relationship Between SBS Symptoms and Objective Signs in Experimental and Reference Wards (n=222).

objective signs accompanied significant changes in SBS symptom rates. They found that objective changes had also taken place as shown in Table 4. Wyon concluded that the research had shown "objective measures confirmed subjective SBS symptoms, both between people

Experimental Condition	SBS Symptom Effect	Objective Evidence in Same Population
Ionization	Alleviated dry throat ($p<0.05$)	Reported use of throat pastilles that day ($p<0.05$)
Ionization	Reduced dry lips ($p<0.001$)	Observed dry lips ($p<0.10$)
Ionization	Reduced dry skin ($p<0.001$)	Observed dry skin on fingers ($p<0.10$)
Ionization	Reduced brittle nails ($p<0.02$)	Observed cracked or broken nails ($p<0.05$)
Ionization	Reduced dry eyes ($p<0.02$)	Increased inter-blink interval ($p<0.001$)
Increased humidity	Reduced dry skin ($p<0.01$)	Observed dry skin on fingers ($p<0.02$)

Table 4 - Changes in Objective Evidence of Symptoms Corresponding to Experimental Conditions With Positive Effects on Reported SBS Symptoms in Experimental and Placebo Wards (n=339).

under reference conditions and in response to environmental change."

Wyon's Hypotheses on Mechanisms

After appropriate disclaimers regarding the dangers of inferring causality from statistical associations, Wyon put forward some hypotheses regarding the underlying mechanisms for the observed positive effects on SBS symptoms:

- The ionization reduced the density of airborne respirable particles (and the measurements showed that this was the case).
- The lower temperature and increased relative humidity directly affected the moisture balance of the mucous membranes and, therefore, had a positive effect on mucous membrane "flow rates and their ability to deal with airborne particles."

The reduced glare conditions caused "red eyes" less often (as researchers observed with staff).

Again, Wyon stresses that "these are only hypotheses to explain the observed empirical effects of the technical measures on SBS."

IAB Comments

According to Wyon, determining how to mitigate IAQ problems presents substantial ethical and economic challenges. Wyon has shown that an experimental approach can be practical and meet ethical criteria related to experiments involving human subjects. He believes the Malmö approach addressed these ethical questions in ways many other studies fail to consider.

Wyon concluded that field experiments studying the effects of various technical measures on SBS can provide a "cost-effective basis for investment decisions, whether or not the underlying cause of the problem is understood." This, of course, is anathema to many researchers who believe that it's not enough to know that a method works: one has to know why it works. Scientific tradition limits the acceptability of such practical approaches for many in the indoor air community. However, for building owners, managers, tenants, or designers, what works is what counts.

Reference:

David P. Wyon, 1992. "Sick Buildings and the Experimental Approach." *Environmental Technology,* vol. 13, pp. 313-322.

For more information:

David P. Wyon, National Swedish Institute for Building Research, Box 785, 801 29 Gavle, Sweden.

Ventilation

Europeans Publish New Ventilation Guideline

The Commission of the European Communities (CEC) has published a ventilation guideline that establishes a new approach to determining ventilation rates. The approach is two-fold; first, that there should be no more than a negligible health risk for occupants breathing indoor air. Second, that occupants should perceive the air as "fresh and pleasant rather than stale, stuffy, and irritating." It says that "the quality of the indoor air may be expressed as the extent to which human requirements are met. The air quality is [considered] high if few people are dissatisfied and there is a negligible health risk."

The report presents more explicit guidance on indoor air VOC concentrations than has previously been adopted by any authoritative body. The VOC guidelines, if followed, will severely limit pollutant source strengths. The guidelines also allow the designer to specify air quality based on three distinct categories of acceptability: 10%, 20%, and 30% or less of occupants being dissatisfied. Determining acceptability is based on the predicted percent of occupants that will be dissatisfied with the perceived air quality using subjective assessment of the odor, comfort, and irritation aspects of the air.

The document, *Guidelines for Ventilation Requirements in Buildings,* reflects a voluntary consensus among representatives from the CEC member nations. It is a set of recommendations rather than a regulatory document. Its provisions are extremely important; however, they are not free from controversy. Ultimately, each member nation independently determines whether to adopt the *Guidelines'* provisions. However, the publication of the *Guidelines* report is likely to lead to the adoption of at least some of its significant recommendations.

Purpose

The Purpose statement says: "This document recommends the ventilation required to obtain a desired indoor air quality in a space. Selection of low-polluting materials and products in buildings is recommended." The scope statement excludes thermal comfort parameters but references ISO Standard 7730, which is essentially the same set of thermal comfort requirements as ASHRAE Standard 55-1981.

Individuals involved in the *Guidelines'* development and adoption told ***IAB*** that implementing the detailed requirements requires data that are not yet generally available. However, they believe the document will stimulate developing the necessary data. These data include chemical emissions rates from building materials and subjective evaluations of emissions and indoor air.

Pollutant Guidelines

An oft-repeated criticism of ASHRAE Standard 62, *Ventilation for Acceptable Indoor Air Quality,* is that it provides little practical guidance on indoor air pollutant concentrations even though it mandates maintaining IAQ within "acceptable" limits. It provides threshold limit values (TLVs) for occupational exposures and guidance information on scores of contaminants in an appendix. Yet the appendix advises that the TLVs are too high for non-industrial indoor air. It suggests that 1/10 of the TLVs be used as guideline values, but that these values might not protect sensitive individuals. In sum, the ASHRAE standard backs away from establishing exposure guideline values.

Contaminant Exposure

The European guideline does provide direction on contaminant exposures, although it hedges. It references the World Health Organization (WHO) *Air Quality Guidelines for Europe* and provides rather detailed advice on VOCs. Guidance is also given for several indoor air pollutants including radon, gases from landfills and waste sites, combustion products, environmental tobacco smoke, formaldehyde, metabolic gases, humidity, and micro-organisms. Specific discussions of each of these contaminants or categories address sources and public health significance. In most cases, the reader is referred to other publications for more detail. Most of the *Guidelines*' health goals are addressed by referencing existing CEC guidelines (contained in various publications) and the World Health Organization limits (contained in *Air Quality Guidelines for Europe*) for specific substances.

The report does not address complex mixtures or combinations of pollutants. It says that efforts to address combinations are hampered by the diverse nature of the effects of mixtures compared to individual compounds. In different cases effects may be additive, synergistic, antagonistic, or independent. Instead, it says that the "preferred method for indoor air quality management is control of the pollution sources. The choice methods for controlling the dominant sources are source removal/replacement, isolation, and local ventilation."

VOC Control

Guideline recommendations for controlling VOCs refer to two methods. The first is attributed to Lars Mølhave of Denmark. It classifies exposures to total VOC (TVOC) as measured by flame ionization detection calibrated to toluene. The levels are listed as a "comfort range" of <200 $\mu g/m^3$, a "multifactorial exposure range" of 200 to 3000 $\mu g/m^3$, a "discomfort range" of 3000 to 25000 $\mu g/m^3$, and a "toxic range" of >25000 $\mu g/m^3$. The report does not state what the "multifactorial range is, but we know from other work by Mølhave that it refers to a range where individual factors cannot adequately explain the discomfort and health complaints of occupants.

The second method derives from the work of Bernd Seifert of Germany. Starting with Mølhave's work, Seifert establishes a TVOC target guideline value based on looking at the predominant ten compounds in each of six compound classes. The classes (and guidelines for them individually) are alkanes (100 $\mu g/m^3$), aromatics (50 $\mu g/m^3$), terpenes (30 $\mu g/m^3$), halocarbons (30 $\mu g/m^3$), esters (20 $\mu g/m^3$), carbonyls excluding formaldehyde (20 $\mu g/m^3$), and "other" (50 $\mu g/m^3$). The totals from each class are added to derive the TVOC value. A target of 300 $\mu g/m^3$ for TVOC is given, but a disclaimer is immediately added that the values are not based on toxicological considerations. Rather, they are based on existing values and professional judgment about achievable levels.

Then the report says that while the two approaches are different, their practical implications are in agreement. The first suggests a comfort range of <200 $\mu g/m^3$ and the second a target value of 300 $\mu g/m^3$ for TVOC. The report says that since TVOC are "emitted by certain building materials, furnishings, consumer products and equipment, it is recommended to select materials and designs that minimize the emission of VOC."

Perceived Air Quality

The most unique aspect of the guideline is that it establishes three categories of perceived air quality — A, B, and C. The ventilation rates required to achieve each category vary according to the strength of the sources to be controlled and the percent of dissatisfied occupants that is deemed acceptable. Category A limits dissatisfied occupants to less than 10%, category B to less than 20%, and category C to less than 30%.

The notion that design is targeted to achieve a certain level of acceptability derives from the ASHRAE thermal comfort standard. The design temperature range is intended to result in no more than 20% of the occupants expressing dissatisfaction with the thermal environment if the design conditions are met. Since no set of thermal conditions can produce 100% satisfaction, there will always be some occupants who, when asked about their thermal comfort, will express dissatisfaction.

The ventilation standard (ASHRAE Standard 62-1989) borrowed this approach of limiting dissatisfaction as a design basis. As with thermal conditions, there are always likely to be some building occupants who will perceive the air quality as unacceptable under any conditions. The ASHRAE standard is based on limiting dissatisfaction with bioeffluents (emissions from occupants) and uses CO_2 as a surrogate for bioeffluent concentrations. This derives from the historic situation where people bathed far less frequently and human body odor was a significant source of complaints and odor discomfort in buildings. Ventilation rates were established to control body odor concentrations and the ASHRAE ventilation standard still reflects this heritage.

Predicting Dissatisfaction with "Perceived Air Quality"

Dissatisfaction rates are predicted on the basis of the research by Ole Fanger and his colleagues at the Technical University of Denmark. The method involves subjective air quality assessment by trained panels of visitors to a building who render judgments as to the acceptability of the air quality. The judgments are made from a combination of odor intensity, pleasantness, and the degree of

irritation. We see this as one of the weaknesses of the method (and, therefore, the *Guidelines*) — the weighting or precise combination of odor intensity and pleasantness and the degree of irritation are not well defined.

This subjective approach, often referred to as the "olf and decipol" method, or the "Fanger method," involves quantifying the strength of pollution sources by equating one olf to the pollution emitted by one standard person — defined as one who bathes every 1.6 days. One decipol "is the perceived air quality in a space with a pollution source strength of one olf, ventilated by 10 l/s [20 cfm] of clean air." Thus, 1 decipol = 0.1 olf/(l/s). Figure 3 shows the relationship between ventilation rate in l/s per standard person and percent dissatisfied as predicted by Fanger's model. This approach is directly traceable to the CO_2-based ASHRAE standard.

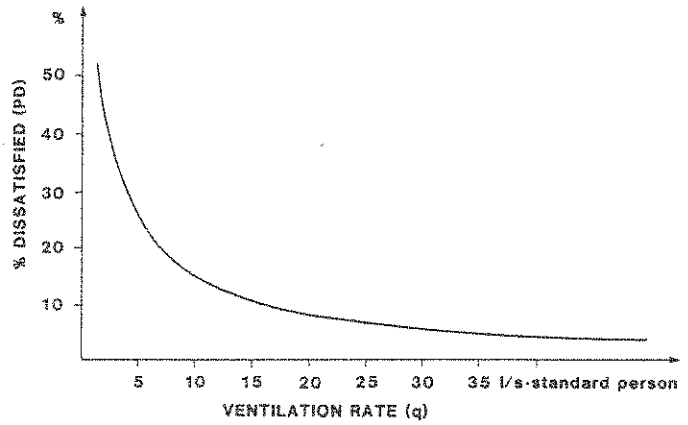

Figure 3 - Dissatisfaction Caused by a Standard Person (one olf) at Different Ventilation Rates.

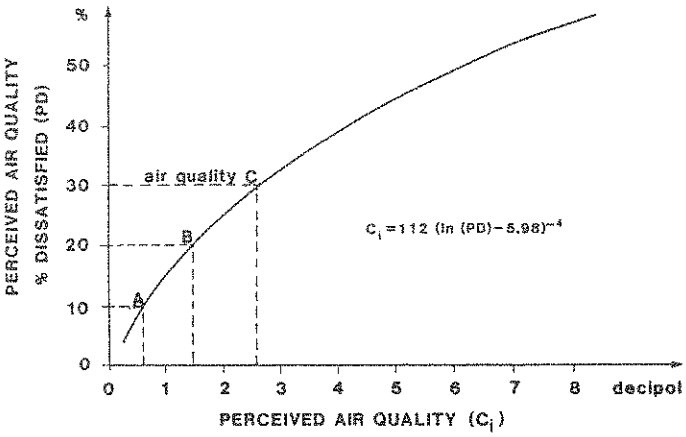

Figure 4 - Relation Between Perceived Air Quality Expressed by the Percentage of Dissatisfied and Expressed in Decipols.

Figure 4 shows the relationship between "perceived air quality" (in decipols) and the *Guidelines'* percent dissatisfied with the three levels, A, B, and C, plotted based on 10%, 20%, and 30% dissatisfied respectively. We recently pointed out to Fanger that we think the x-axis is mislabeled; if the units are decipols, then the label should not be labeled "perceived air quality" but "perceived air pollution" instead.

Limitations of Subjective Evaluations

A widely acknowledged weakness of relying on subjective evaluations is that there may be no relationship between perceived air quality and human health effects from harmful pollutants. For example, harmful odorless gases may contain radon, asbestos, and other carcinogens; carbon monoxide is odorless and lethal. Some members of the CEC committees that developed and adopted the guidelines were concerned about exclusive or excessive reliance on subjective evaluations of air quality. However, the *Guideline* argues, the risks of potential health effects are normally lessened when poor perceived air quality is addressed by removing pollutant sources and improving ventilation. This is also the argument of those who support the ASHRAE standard's related approach. The problem is that there is no guarantee.

Another major weakness is that indoor air acceptability cannot be determined until a building is completed and occupied. Then it is too late to revise the design to achieve better air quality. Advocates argue that, as more data become available on the strengths of emissions from building materials and other sources, it will be possible to add the subjectively perceived strengths of separate sources and predict the concentrations in the completed building under various ventilation rates. The proposed procedure is similar to one already used to estimate airborne concentrations of VOC from material sources based on environmental chamber measurements of chemical emissions. Critics argue that sufficient data won't become available in the foreseeable future to make the method practical. Odor/irritation research by William S. Cain and his colleagues at Yale suggests that odors are not necessarily additive while irritation responses are additive for separate chemicals. Defenders of the *Guidelines'* approach note that it is only a qualitative guideline; its real intent is to push things in a positive direction.

Determining Sensory Pollution Loads

Fanger and his collaborators report that sensory pollution loads can be obtained by adding separate loads. He includes occupants, buildings, furnishings, and ventilation systems on his list of usual sources. Therefore, to design ventilation, we have to know all of the pollution

	Sensory pollution load olf/(m² floor) Mean	Range
Existing buildings		
Offices[1]	0.3	0.02-0.95
Schools[2] (classrooms)	0.3	0.12-0.54
Kindergartens[3]	0.4	0.20-0.74
Assembly halls[4]	0.5	0.13-1.32
Low-polluting buildings (target values)		0.05-0.1

[1] Data for 24 mechanically ventilated office buildings.
[2] Data for 6 mechanically ventilated schools.
[3] Data for 9 mechanically ventilated kindergartens.
[4] Data for 5 mechanically ventilated assembly halls.

Table 5 - Pollution Load Caused by the Building, Including Furnishing, Carpets, and Ventilation System.

sources and their olf values. Then we calculate the total sensory pollution load (olf/m^2) in order to determine the required ventilation to achieve the target air quality level: A, B, or C.

However, the report indicates that presently data are available "...for only a few materials." Therefore, it says, a more feasible approach is to estimate the pollution loads in different types of existing buildings. The report provides some information developed by Fanger on typical sensory pollution loads based on field research. The sensory load is defined as the pollution load from those sources that impact perceived air quality. Fanger and his collaborators at the Technical University of Denmark in Copenhagen have evaluated the sensory pollution loads (given in olf/m^2 of floor area) in a variety of building types and published their results elsewhere. These results are tabulated in the report and are shown in Table 5.

Reviewing Table 5, we see a very large range of olf values for the building types listed. Offices varied by a factor of 47 for the 24 mechanically ventilated offices studied. The researchers evaluated far fewer buildings for the other building types and found smaller ranges of sensory pollution loads. We expect that if more buildings in each building type were evaluated, the range of olf/m^2 values observed might increase. This tells us that we cannot simply assume what a pollution load will be; we must identify sources in each building we design to accurately predict the sensory pollution loads.

The report acknowledges the wide range of values occurring in various buildings. To address this it says that "...it is essential that new buildings be designed as low-polluting buildings." It then provides target values for "low-polluting" buildings of the types listed in Table 5 as 0.05-0.1 olf/m^2 floor area. To achieve these target values, the report says, requires "a systematic selection of low-polluting materials for the building including furnishing, carpets, and ventilation system." [In Europe, the term "carpet" often refers to all rolled, sheet or tile floor coverings including textile and resilient materials.]

While we think it's a good idea to specify low-polluting materials, we do not see how it resolves the complex issues in estimating pollution loads during design in order to specify the appropriate ventilation rate and achieve a target air quality level. Most designers do not have access to any information on pollution source strengths of various

	Sensory Pollution load olf/occupant	Carbon dioxide l/(h · occupant)	Carbon monoxide[2] l/(h · occupant)	Water vapor[3] l/(g · occupant)
Sedentary, 1-1/2 met[1]				
0% smokers	1	10		50
20% smokers[4]	2	19	$11 \cdot 10^{-3}$	50
40% smokers[4]	3	19	$21 \cdot 10^{-3}$	50
100% smokers[4]	6	19	$53 \cdot 10^{-3}$	50
Physical exercise				
Low level, 3 met	4	50		200
Medium level, 6 met	10	100		430
High level, (athletes), 10 met	20	170		750
Children				
Kindergarten, 3-6 years, 2.7 met	1.2	18		90
School, 14-16 years, 1-1.2 met	1.3	19		50

[1] 1 met is the metabolic rate of a resting sedentary person (1 met = 58W/m^2 skin area, i.e. approx. 100W for an average person).
[2] From tobacco smoking.
[3] Applies for persons close to thermal neutrality.
[4] Average smoking rate 1.2 cigarettes/hour per smoker, emission rate 44ml CO/cigarette.

Table 6- Pollution Load Caused by Occupants.

materials, and even the research community has extremely limited information. (See IAB Vol. 1, No. 6, pp. 1-11.) The report conveys a sense of a very quantitative approach to design for sensory pollution load and acceptability. However, in the end, the report leaves practical implementation to a future time when far more data will be available.

The report provides some data on sensory pollution loads from certain types of occupants (see Table 6), but it does not provide any values for the pollution contributions of the other sources identified as important, i.e., "the building including furnishings, carpeting, and ventilation system." Table 6 shows some examples based on a standard person emitting 1 olf. A smoker emits 6 olfs while smoking, a physically active person emits 10 to 20 olfs, and school children emit 1.2 to 1.3 olfs, depending on age.

The report concludes this section by recommending the calculation of total sensory pollution loads "by simple addition of the loads from the individual pollution sources in the space." This, the report says, provides a reasonable first approximation of the combined loads. Then it qualifies this statement by saying that future research might show that simple addition of individual loads will fail to adequately predict total pollution loads.

We find that qualification an important one in light of William Cain's odor and irritation research. His work shows that while most irritant responses add together in a simple way, many odors do not. Since Fanger's approach evaluates some combination of odor and irritation, it may be that for more irritating substances, additive approaches will be inadequate. Since irritation may be a more reasonable predictor of discomfort or significant potential health effects, we think the sensory pollution load as defined by Fanger's "perceived air quality" may be an unreliable predictor of occupant dissatisfaction, SBS symptoms, and building related illness.

Other Factors

The report says that the quantity of outdoor air required depends on the quality of that air. It lists perceived values for outdoor air quality, but these listings are rather vague with respect to the decipol values. Air "at sea" is rated as 0 decipol, air in towns with "good air quality" is rated as <0.1 decipol, and air in towns with "poor" air quality is rated as 0.5 decipols. These values are of little use to the designer and, again, leave us only with qualitative information for design.

The report's final consideration for determining required ventilation rates is the efficiency of ventilation. It uses pollution removal efficiency (rather than outside air delivery efficiency like ASHRAE Standard 62). The lower the pollution removal efficiency, the greater the required ventilation rate. This is a logical and important consideration.

The required ventilation for health and comfort "...should be calculated separately and the highest value used for design." Thus, the report does not rely solely on either evaluation, but suggests full consideration of both. It then gives examples of how to calculate the required ventilation for comfort (sensory pollution load) and then for health based on some examples.

IAB Comments

In the end, the data do not exist to adequately predict quantitative pollution loads during design. The report intends to stimulate research that will increase our ability to do so and to make us more aware of qualitative and semi-quantitative bases for design. These are important and reasonable goals. Unfortunately, we think the report undermines its potential impact by creating expectations regarding quantitative methods of building design that are beyond current capabilities and feasibility.

References:

CEC, 1992. *Guidelines for Ventilation Requirements in Buildings*. Report No. 11, European Concerted Action: Indoor Air Quality and Its Impact on Man. (EUR 14449 EN), Commission of the European Communities, Directorate General for Science, Research and Development, Joint Research Centre - Environment Institute, Ispra, Varese, Italy.

Available from Commission of the European Communities, Joint Research Centre - Environment Institute, Ispra, 21020 (Varese) Italy. Fax +39 332 78 50 22 or +39 332 78 92 22.

WHO, 1987. *Air Quality Guidelines for Europe*. Copenhagen: WHO Regional Office for Europe. WHO Regional Publications, European Series: No. 23.

EPA Group Labels ETS a Human Carcinogen

On July 21st, the Indoor Air Quality and Total Human Exposure Committee of EPA's Science Advisory Board (SAB) concluded two days of meetings by recommending classifying environmental tobacco smoke (ETS) as a known human (Class A) carcinogen. The review committee recommended some significant re-writing of the report, but it did not ask to see it again. One committee member saw this as an indication of the strength of the committee members' agreement with the report's conclusions. ***IAB*** sources close to the scene predict that EPA Administrator William Reilly will formally declare ETS a Class A carcinogen when the SAB-recommended modifications to the report are completed later this year or early next year.

The report estimated that approximately 3,000 lung cancer deaths per year can be attributed to ETS exposure. This will surely trigger a new wave of anti-smoking ordinances in public-access buildings and a tightening of existing ordinances and their enforcement. The impact on building owners, operators, occupants, and designers will be significant.

Most of the studies the report relied on were of spousal exposure to ETS: female non-smoking spouses of smokers. That is why it was somewhat surprising to see that the report estimated that 2,200 of the estimated annual ETS-related excess deaths are from non-home exposure whereas it estimated that only 800 of them are from spousal smoking. The implication of the non-home ETS exposure impact is sure to fuel the fires of those who would extinguish tobacco smoking products in public buildings and workplaces.

Report Blames Childhood Respiratory Illness on ETS

The study also reviewed several studies on the risks of respiratory illness in children of smokers. The SAB found increased risks where children are exposed to ETS either through pre-natal maternal smoking or through ETS during childhood. Parental smoking affects between nine- and twelve-million American children less than five years of age. Some of the respiratory effects identified by the report are irritation (cough, sputum, or wheeze); acute lower respiratory tract disease (pneumonia, bronchitis, and bronchiolitis); acute middle ear infections and indications of chronic middle ear infections (predominately middle ear effusion); reduced lung function; increased incidence of asthma and exacerbation of symptoms in asthmatics; and acute upper respiratory tract infections (cold and sore throats).

The report describes the evidence of a probable connection between parental smoking and sudden infant death syndrome (SIDS) as inadequate, although the Surgeon General and the World Health Organization have attributed an estimated 700 SIDS deaths a year to maternal smoking. The report says that there is not enough direct evidence to make any risk estimates for this important health problem that kills an estimated 5,000 infants annually.

While the report focuses on the respiratory health effects of ETS exposure, it did not review the evidence that ETS exposure is a risk factor for cardiovascular disease. The report simply mentions that recent toxicology and epidemiology studies "suggest that ETS exposure may be a risk factor for cardiovascular disease," the leading cause of death in the United States.

Implications for Indoor Air

State and local governments throughout the country will probably adopt new or strengthen existing public smoking restrictions when Administrator Reilly takes formal action. That may mean eliminating smoking completely from many buildings, designating smoking-permitted areas with special high flow outside air ventilation, and exhausting ETS-contaminated air directly to the outside.

While some or all of these measures have been taken in many buildings, both public and private, there still are many jurisdictions where legal requirements have not mandated such complete protection of non-smokers from exposure to ETS. Furthermore, the report and probable EPA official action are likely to stimulate more efforts to secure smoke-free workplaces in non-regulatory settings. Anti-smoking groups are still trying to persuade OSHA to act to limit workplace ETS exposure.

A side benefit for building owners is the reduction in filtration costs, ventilation requirements and cleaning costs in smoking permitted areas. And, to some extent, ETS can be a cause of disk drive crashes in computers and failures of other electronic equipment when sticky, small particles accumulate on heads and lead to arcing, bridging, or other failure mechanisms.

An important presumed benefit for employers is a reduction in health care costs for workers and lost work time due to ETS-related illness. Advocates of improved IAQ are flocking to the argument that a better environment improves productivity, and lost work time due to illness is a significant cost.

Reference:

U. S. EPA, 1992, "Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders." EPA/600-6-90/006B. May 1992. Office of Research and Development, Washington, DC 20460.

News

Pentachlorophenol-Treated Beams Removed From School

Pentachlorophenol-treated beams have been removed from the library of a Ransom, West Virginia school where the beams were apparently illegally used. EPA banned pentachlorophenol (PCP) for interior use in 1984, although industry lawsuits delayed the implementation of the ban for a couple of years. After a several months' battle with the local school board and the EPA, an attorney representing the school librarian succeeded in convincing authorities that the beams should be removed.

PCP is a wood preservative widely used throughout most of the world. It is extremely durable, effective, and transparent. These features are why architects specify its use on exposed wood including glu-lam timbers. Until the EPA ban, it was a common ingredient in many wood preservative products, wood finishes, paints, and other building products. Its interior use is now restricted only to exterior wood sash and trim that risks deterioration from exposure to the weather. In those cases, it still must be sealed or covered in order to reduce potential occupant exposure.

PCP is a known teratogen and, in 1989, the US National Toxicology Program found substantial evidence of carcinogenicity. It is also known to cause liver and skin disease. Because it is persistent in the environment, once it is present, exposure continues for a long time.

PCP is regarded as a significant threat to the health of building occupants where its use (as in the case of pressure-treated lumber) is substantial. Concentrations approaching two-tenths of a percent were found in PCP pressure-treated glu-lam timbers installed in a Long Beach, California, state office building we investigated in the early 1980s. There we found airborne concentrations ranging from a few micrograms per cubic meter ($\mu g/m^3$) up to as high as 50 $\mu g/m^3$. Sealing the beams with two coats of polyurethane varnish and increasing the building's ventilation rate effectively lowered the concentrations to levels deemed acceptable to the California Department of Health Services. However, over time, the varnish coating did not seem to control emissions and problems with the ventilation system led to recommending its replacement.

We were shocked to learn last fall that PCP pressure-treated beams were installed in a school as recently as last year. More recently we learned that PCP pressure treatment was specified by the architect of a Texas school for beams throughout the building. We are still trying to determine whether the beams were actually treated during construction of the school which took place in 1987-88.

These two cases made us aware once again of how imperfectly our systems protect public health. EPA has never effectively dealt with the tens (or perhaps even hundreds) of thousands of log cabins throughout the country constructed with PCP-treated wood. Building occupant exposure to PCP continues for decades after its use because of its very low volatility.

Children risk the greatest exposure because of skin contact and inadvertent ingestion of PCP on surfaces, in house dust, and elsewhere. Studies of log home residents show that children's body burdens are several times those of adults living in the same homes. Some published papers on PCP have attributed most exposure to contaminated food. However, our analysis, presented at the International Society of Exposure Assessment meeting in Las Vegas three years ago, found that indoor air and probably dust exposure account for a major fraction of PCP exposure. (See the reference at the end of this article.)

PCP Risk Reduction

What should you do if your home, school, or other structure is contaminated? An immediate remedy is a major increase in outside air ventilation. A secondary measure is to seal the treated beams, but this is only minimally successful and brings with it the additional exposure to the solvents and other chemicals used in the sealant. A third exposure control measure is to minimize dust residues at all times by wet mopping floors and wet-wiping surfaces or using a high-efficiency vacuum cleaner. (Ordinary vacuum cleaners increase airborne

concentrations although they may control dust accumulation.) Treated wood, such as window sills, trim, and furniture, that is accessible to small children should be protected to eliminate direct contact.

IAB Wants to Know

If you know of other recent indoor wood preservative uses of PCP, or of on-going exposure in indoor environments, please send information to the ***IAB***. We will assemble the information and forward it to the appropriate officials at EPA as well as continue to monitor the situation and report on it in these pages.

References:

"General Population Exposure to Pentachlorophenol." in *Proceedings of the EPA/A&WMA Specialty Conference, Total Exposure Assessment Methodology,"* November, 1989, Las Vegas, Nevada. Pittsburgh: Air & Waste Management Association, (P. O. Box 2861, Pittsburgh, PA 15230). pp. 86-97.

Publications

California Releases IAQ Booklet

The California Air Resources Board (CARB) released an eight-page color booklet introducing the basic concepts of indoor air pollution. "Reducing Indoor Air Pollution" is available at no cost from ARB in Sacramento (see address below).

While there is nothing significantly new about the booklet, it is important because CARB has traditionally been concerned with ambient air quality. The booklet calls indoor air pollution a "serious public health problem," saying that Californians spend an average of 87% of their day indoors.

To obtain a copy, or for more information, write the California Air Resources Board, Research Division, P. O. Box 2815, Sacramento, CA 95812, (916) 322-8282.

Publications

EPA Describes Its IAQ Activities

EPA has published the 1992 update of federal activities and contacts working on IAQ issues and of publications related to those activities. Compiled by the Indoor Air Division (IAD) of EPA's Office of Air and Radiation, the 76-page booklet contains a wealth of information on US government indoor air research and program activities as of February 1992. It serves as a useful directory to key government IAQ officials.

EPA's Indoor Air Division serves as co-chair of the Interagency Committee on Indoor Air Quality (CIAQ), and it currently leads federal IAQ efforts. Co-chairs include the Department of Energy, the Consumer Products Safety Commission, Health and Human Services (includes NIOSH), and the Department of Labor (includes OSHA). Ten other agencies are also members of the CIAQ.

The activities listings include several column headings including issue/major activity, purpose, status, lead office/agency, and contact. The contact is an identified individual and the phone number is provided. This makes the document extremely useful for those wanting more information on a listed activity.

The booklet begins with more than four pages of alphabet soup translations for all of the acronyms used throughout the rest of the document. There are 62 pages of activity listings followed by six pages of publications. Reports are available for many of the activities, and those wanting more information can request them from the listed contact person.

The hands-down winner for the most-listed contact person in the directory is Dr. Susan Rose of the Department of Energy. Dr. Rose oversees DOE's radon health-effects research of which there are 8 1/2 pages of listed activities. Most of them are described as "on-going" in the status column. [A hint to ***IAB*** readers: efforts to reach Dr. Rose by phone are rarely successful, presumably due to her very extensive responsibilities. But it's worth the trouble, if you can get through: Dr. Rose is not only knowledgeable, she is our nominee for the government's most talented comedian.]

Many of the listings will be of particular interest to researchers since the vast majority of them are about research activities. An example of a listing that might be extremely useful is as follows:

> *Issue/Major Activity*: "Indoor Air Reference Bibliography."
>
> *Purpose*: Maintain an extensive bibliography of reference materials on indoor air pollution.
>
> *Status*: Publication of bibliography containing over 4,500 citations. Published annually.

Lead Agency/Office: EPA/ORD/ECAO. [Office of Research and Development/Environmental Criteria Assessment Office].

Contact: Beverly Comfort, 919-541-4165.

Another example, one that may be of interest to fewer readers, but is a very important health-effects study that is not well-publicized;

Issue/Major Activity: Risk Characterization Methodology for Indoor Carcinogens

Status: Publication of risk characterization methodology; review of risk characterization studies: 3/91; indoor concentrations of environmental carcinogens: 1/91; methods of analysis for environmental carcinogens: 6/90.

Lead Agency/Office: EPA/ORD/ECAO.

Contact: Michael Berry, 919-541-4172.

There are literally hundreds of entries, some of which are sure to be of interest to some of our readers. To obtain a free copy, write the Public Information Center (PM-211B), U. S. Environmental Protection Agency, 401 M Street SW, Washington DC 20460.

Conference

"IAQ '92: Environments for People"

Continuing its tradition of annual IAQ conferences, ASHRAE is organizing "IAQ '92: Environments for People." Co-sponsors of this year's conference are the American Conference of Governmental Industrial Hygienists (ACGIH) and the American Industrial Hygiene Association (AIHA). The conference will address "investigating and evaluating contaminants and other factors and responses; solutions and recommendations," according to the announcement.

Scheduled to take place October 18-20 in San Francisco, IAQ '92 is organized around five sessions of invited papers followed by discussions by the panel members. The discussions are intended to stimulate interaction among individuals whose views are not necessarily in agreement. They will tackle some of the difficult questions around the appropriateness of industrial standards (TLVs) for exposure to hazardous agents for application in the indoor environment. They will also address the controversies regarding the appropriateness of sampling indoor air for bioaerosols, methods for determining VOCs in indoor air, and state-of-the-art procedures for investigating IAQ.

The conference will take place at the Golden Gate Holiday Inn, San Francisco, California, beginning with a welcoming reception on Sunday evening and followed by two and one-half days of meetings. The proceedings will be available for purchase at the conference or afterwards from ASHRAE in Atlanta.

For more information:

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle NE, Atlanta, GA 30329-2305, (404) 636-8400, fax (404) 321-5478.

Call for Papers

AIA Announces "Designing Healthy Buildings"

The theme of this year's American Institute of Architects (AIA) Committee on the Environment (COTE) meeting is "Designing Healthy Buildings." The AIA has issued an announcement and Call for Papers for its annual meeting scheduled to take place in Los Angeles on November 13, 1992. Papers of no more than ten pages describing an existing design or study, either completed or under construction, are due October 1, 1992. Selected papers will be published in the symposium proceedings and six will be selected for presentation at the symposium.

Papers may address the following aspects of IAQ technology or industry trends:

- Public policy, codes, and regulations.
- New construction.
- Renovation.
- Materials.
- Overall approach.

Authors must submit a minimum of one black and white photograph of the project, if built, or a sketch of the concepts discussed. All authors must be available, if selected, to present their papers to the symposium. Presentations will be fifteen minutes in length and limited to ten

slides. Presenters will not be funded to attend the meeting but registration fees will be waived.

For more information about the call for papers, the symposium, or the AIA activities in indoor air, contact Kristine Dombrowski, AIA, 1735 New York Avenue NW, Washington, DC 20006, (202) 626-7452, fax (202) 626-7518.

Letters

Guttmann on Thermal Comfort

Dear Hal,

I have just received the March issue of the ***Indoor Air BULLETIN***, and feel compelled to respond to your lead article, "Field Research Results and ASHRAE Standards - Do They Conflict?"

Many consultants, myself included, have felt for a long time that the ASHRAE comfort chart needs to be shifted downward. The article discusses the parameters which affect subject response to the tests, but in my opinion, there are two parameters which are never adequately addressed. Both are difficult to quantify, which may be the reason why everyone shies away from them.

We are all familiar with traveling to the East Coast in winter, and finding hotel rooms, restaurants, even residences overheated. In summer we also find the same spaces too warm; one hears people talk about the danger of leaving an air conditioned space and encountering the hot and humid outdoors. In spite of the lack of clinical evidence, this is supposed to increase susceptibility to infection.

On the other hand, our cousins in London, England, where the climate is similar to, say, New York, are accustomed to much lower winter indoor temperatures, particularly in residences. in summer, indoor temperatures are generally more like the East Coast.

What does all that mean? I believe one factor is physiological - in climates where the difference between summer and winter is more dramatic than on the West Coast, higher winter indoor temperatures are tolerated. Then why do the Londoners keep things cooler? That involves the other factor, which is cultural.

Londoners do not expect cooling in summer; they do not have air conditioned cars, and air conditioned homes are rare. The colder winter indoor temperatures are based on tradition - it is considered unhealthy to keep rooms too warm. There is the "thermal shock" again!

As for the article - I, and many of my colleagues, would expect tests in San Francisco to find the ASHRAE comfort chart too high. We typically design for 70°F to 72°F for cooling and 68°F to 70°F for heating.

It would be great if some clever researcher could introduce these two factors - lets call one regional and one cultural - into the comfort equation! Or maybe publish regional (cultural) charts separately, based on regional (cultural) tests.

Very truly yours,

Karl Guttmann, PE
San Francisco

Letters

Judy Spear on MCS

Dear Mr. Levin,

I lost my job (as editor at the Museum of Fine Arts in Boston) because of hypersensitivity reactions to indoor air pollution, so with regret I must decline a subscription. Though I'm encouraged to see your concerns prompting scientific inquiry into causes and solutions, it's frustrating to read of cautious skepticism as to the existence of MCS. Your editorializing role is critical here for the influence you can exert on the medical community: call it hyperreactivity, mucosal irritation, or whatever -chemical sensitivity is deleterious and disabling.

The articles in your ***BULLETIN*** (vol. 2, no. 3) give little flesh-and-blood palpability to the statistics for building-related illness. Whether our exposures have been low level or massive, we fear the degenerative effects of immune-system and CNS disorders, and we need to see implemented quickly the legal protections now being extended through anti-smoking litigation.

Even if carpeted rooms and new cars and retail outlets reeking of formaldehyde and VOCs at unacceptable levels continue to be off limits, we should not have to wait decades for the right to a safe workplace - and the right to legal redress for victims of handicap discrimination. I've

petitioned both the Massachusetts Commission against Discrimination and OSHA (whose Section 11[c] prohibits retaliation for reporting health-and-safety violations), but both agencies have dismissed my carefully documented claims as "unprovable." Moreover, except in the case of worker's compensation — which I stand a chance of getting — I can find no attorney willing to represent me on a contingent-fee basis.

Judy Spear
Lancaster, MA

Letters

Phillips on Standard 62

[The following are excerpts from Mr. Phillip's letter.]

Dear Hal:

Standard 62 addresses complex issues. If ASHRAE Standard 62 is to be understood by the engineering masses, either:

- The Standard must be altered to present these concepts in a simpler fashion, or;
- A complimentary document which explains the Standard through examples which these guys can follow must be developed, or;
- Training programs on the Standard must be taken to the design professionals, because I doubt that they will go far from home or spend much of their own time or money for training, or;
- Legislation must be enacted requiring design engineers to prove competency in ventilation system design for IAQ before certifying ventilation system designs, or;
- Insurance companies must require mechanical system design professionals to demonstrate competency in ventilation system design for IAQ in order to receive professional liability coverage.

In the absence of litigation or legislation (i.e. fear or force), it will be much easier to take the Standard to the masses than have the masses come to the Standard.

Sincerely,

Bert Phillips, P. Eng.
UNIES Ltd., Winnipeg, Manitoba, Canada

Calendar

Domestic Events

August 19-20, 1992. **International Energy and Environmental Congress (Conference and Exposition)**, sponsored by the Association of Energy Engineers, Hyatt Regency O'Hare Exposition - Rosemont O'Hare Convention Center, Chicago, Illinois. Contact: Association of Energy Engineers, 4025 Pleasantdale Road, Suite 420, Atlanta, GA 30340. (404) 447-5083, fax (404) 446-3969. *"Designing and Operating Healthy Buildings" is the title of a two-day course being offered in conjunction with the Conference. Course registration is $685 for AEE members, $785 for non-members. Conference and exposition registration is $595 for AEE members, $695 for non-members. Booths are available for $14.50 per square foot.*

August 30 - September 5, 1992. **"Achieving Technical Potential: Programs and Technologies that Work!"** ACEEE 1992 Summer Study on Energy Efficiency in Buildings, Asilomar Conference Center, Pacific Grove, California. Sponsored by The American Council for an Energy-Efficient Economy. Contact: ACEEE 1992 Summer Study Office, 2140 Shattuck Avenue, Suite 202, Berkeley, CA 94704. *The ten topics include "human dimensions" of which indoor air quality, health and comfort are a part.*

September 11-14, 1992. **AIA Committee on the Environment**, Steering Group, Ball State University, Muncie, Indiana. Contact Pat Lally, AIA Headquarters, Washington, DC.

September 15-17, 1992. **Orientation to Indoor Air Quality**, sponsored by Office of Continuing Professional Education, Rutgers University, New Brunswick, New Jersey. *See listing under July 14-15.*

September 21-22, 1992. **"Indoor Air Quality"** Course, Madison Wisconson. Sponsored by the University of Wisconsin Department of Engineering, Professional Development. Contact Engineering Registration, The Wisconsin Center, 702 Langdon Street, Madison, WI 53706 (608) 262-1299, or (800) 462-0876, fax (608) 263-3160. *Registration fee is $585 for this two-day course taught by Charles Dorgan, James Woods, and Michael Hodgson.*

September 22-25, 1992. **International Symposium on Radon and Radon Reduction Technology**, Minneapolis, Minnesota. Contact: For registration information, Diana, Conference of Radiation Control Program Directors, Inc., (502) 227-4543, Fax (502) 227-7862.

September 30 - October 2, 1992. **"Lead-Tech '92: Solutions for a Nation at Risk,"** Hyatt Regency Hotel, Bethesda, Maryland. Sponsored by IAQ Publications, Inc. Contact: Mary Lou Downing, Conference Manager, Lead-Tech '92, 4520 East-West Highway, Suite 610, Bethesda, MD 20814. (301) 913-0115; Fax (301) 913-0119. *The sponsors say this is the first industry-wide lead detection and abatement conference and exposition. Registration fee is $525 per person ($475 before September 4th). Conference topics include public programs and policy; lead detection and abatement; blood lead screening, diagnosis and treatment; occupational safety and health; and litigation and liability.*

October 6-7, 1992. **ASTM Subcommittee D22.05 on Indoor Air; Fall Meeting**, contact George Luciw, Staff Manager, ASTM, 1916 Race Street, Philadelphia, PA 19103-1187, (215) 299-5571, fax (215) 299-2630.

October 18-20, 1992. **IAQ 92 - Environments for People,** Golden Gate Holiday Inn, San Francisco, California. Sponsored by ASHRAE, ACGIH, and AIHA. Contact: Jim Norman, Manager of Technical Services, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle NE, Atlanta, GA 30329, (404) 636-8400. *Registration fees are $425 ($375 for ASHRAE Members) before September 4, and $25 more thereafter. Student registration fee is $25.*

October 19-21, 1992. **Indoor Air Quality Continuing Education Course**, American Industrial Hygiene Association, Salt Lake City, Utah. Contact: Continuing Education, AIHA, P.O. Box 8390, White Pond Drive, (216) 873-2442, fax (216) 873-1642.

October 28-30, 1992. **World Environmental Engineering Congress**, Sponsored by Association of Energy Engineers (AEE), Atlanta, Georgia. Contact: AEE, 4025 Pleasantdale Road, Suite 420, Atlanta, GA. 30340. (404) 447-5083, fax (404) 446-3969. *Registration fee: $550 AEE Member, $650 AEE non-member. Booths are available for $16.50 per square foot.*

November 13, 1992. **Indoor Air Quality Symposium**, American Institute of Architects Committee on the Environment, Los Angeles, California. Contact: Pat Lally, AIA, Washington, DC. 1735 New York Avenue NW, Washington, DC 20006, (202) 636-7451.

January 25-27, 1993. **ASHRAE Winter Meeting and International Air-Conditioning, Heating, and Refrigerating Exposition**, Palmer House, Chicago, Illinois. Contact ASHRAE Meetings Department, 1791 Tullie Circle NE, Atlanta, GA 30329, (404) 626-8400.

May 3-7, 1993. **Air & Waste Management Association Annual Symposium**, "Measurement of Toxic and Related Air Pollutants," Omni Hotel and Convention Center, Raleigh, North Carolina. Contact Martha Swiss, A&WMA, P. O. Box 2861, Pittsburgh, PA 15230, (412) 232-3444, fax (412) 232-3450. *Abstracts of 200 words are due by Nov. 30, 1992.*

June 26-30, 1993. **ASHRAE Annual Meeting**, Radisson Hotel, Denver, Colorado. Contact: See listing above under January 23-27, 1993.

International Events

August 26-29, 1992. **Fourth Annual Meeting of the International Society for Environmental Epidemiology (ISEE) and the International Society of Exposure Analysis** (ISEA), Cuernevaca, Morelos, México. Contacts: For registration, Instituto Nacional de Salud Pública, Av. Universidad 655, Col. Santa Maria Ahuacatitlán, 62508 Cuernavaca, Morelos, México. Attn: Dr. Carlos Santos, Burgos. Tel. 52-73-11-01-11, Fax 52-73-11-11-56. For travel and hotel information, contact Viajes Camelu, S.A. de C.V., Vicente Guerrerro No. 801-1, Col. Lomas de la Selva, Cuernevaca, Morelos, México 62250. Tel 52-73-17-36-88, Fax 52-73-17-37. *There is always lots of indoor air content to the ISEA meetings. These are usually exceptionally valuable meetings, although the impact of the Cuernevaca venue is difficult to predict.*

September 2-4, 1992. **Roomvent '92, The Third International Conference on Air Distribution in Rooms**. Aalborg, Denmark. sponsored by Danish Association of HVAC Engineers. Contact: Danish Association of HVAC Engineers, Ørholmvej 40B, DK-2800 Lyngby, Denmark.

October 7-9, 1992. **"Indoor Air Quality, Ventilation, and Energy Conservation in Buildings"** — 5th International Jacques Carier Conference, Hotel Chateau Champlain, Montreal, Canada. Organized by Centre for Building Studies, Concordia University. Contact: Fariborz Haghighat, Centre for Building Studies, Concordia University, Montreal, Quebec, Canada H3G 1M8. (514) 848-3192, fax (514) 848-7965. *The conference preliminary program looks very interesting. Registration is $515 (CND) including a copy of the Conference Proceedings. Student fee is $50 (CND) but does not include lunch or a copy of the Conference Proceedings which may be purchased separately.*

October 12-16, 1992. **Second International Course on Sick Building Syndrome**, sponsored by the Nordic Institute of Occupational Health (NIVA). Hotel Oranje Boulevard, Noordwijk aan Zee, The Netherlands. Contact: Gunilla Ahlberg, NIVA, Topeliuksenkatu 41 a A, SF-00250 Helsinki, Finland. Tel +358 0 474 498. Fax +358 0 414 634. *A five-day course intended for occupational safety and health experts and industrial hygienists working in the field of indoor air quality. Enrollment limited to 50.*

February 17-19, 1993. **"Building Design, Technology & Occupant Well Being in Cold and Temperate Climates,"** Palais des Congrés, Brussels, Belgium. Contact: ATIC-CDH, chausee d'Alsemberg 196, B-1180 Brussels, Belgium. Tel. 32-2-348-05-50; Fax 32-2-343-98-42.

March 4-6, 1993. **Second Spanish and Interamerican Air Conditioning and Refrigeration Congress—CIAR '93**, Madrid, Spain. Contact CIAR '93, Parque Ferial Juan Carlos 1, 238067, Madrid, Spain. Tel 722-50 00. Telefax 722 57 90.

July 4-8, 1993. **Sixth International Conference on Indoor Air Quality and Climate, Indoor Air '93**, Helsinki, Finland. For more information, a copy of the conference announcement, or the call for papers, contact the confeence secretary at: Indoor Air '93, P.O. Box 87, SF-02151 Espoo, Finland. Fax +358-0-451-3611. *This most important indoor air conference is held every three years and is always a very exciting and rewarding event. Abstracts are due October 1, 1992. Do not hesitate to submit an abstract even if you are not yet certain you will attend.*

November 1-3, 1993. **Clima 2000**, Queen Elizabeth Conference Centre, London, England. Contact: Anne Gibbins, CIBSE Headquarters, 222 Baltham High Road, London, SW 12 9BS, fax 44-1-6755449.

Indoor Air BULLETIN

Hal Levin, Editor and Publisher
Subscription Manager: Gina Bendy
Editorial Office: 2548 Empire Grade, Santa Cruz, CA 95060; (408) 425-3946 FAX (408) 426-6522
Subscription Office: P.O. Box 8446 Santa Cruz, CA 95061-8446: (408) 426-6624 FAX (408) 426-6522

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Indoor Air BULLETIN sincerely invites letters or any comments you may have on either the topics presented within or on other indoor environmental issues of interest.