#2359

Policy, Politics and Indoor Air Pollution

Harvey M. Sachs, Ph.D.

This will not be a lecture, but an informal effort to list and respond to several issues that have arisen during this conference. First, let's establish a context: Carry yourself back to about 1790 and the French Revolution, when a number of "opposition" figures lost their heads. One particular morning three people were due to be guillotined. The first was a priest and he was asked if he had any last words. He praised God for the chance to be of service to the community. They put him down on the guillotine, cranked it up, let it go, and it stopped about fifteen centimeters above his head. There was nothing they could do at that time except release him, because double jeopardy was considered unsporting. The second one up was a politician who prayed for Marie Antoinette. The same thing happened, so he was also released. The third person was a builder. When they asked him if he had any last words, he said, "Yes, if you'd countersink that one nail, the thing would work." The moral of the story is that it can be rather hairy to stick one's neck out.

With that in mind, I am going to stick out my neck rather far today and say a number of things which will probably come back to haunt me, but which I think ought to be said to this audience. In response to some questions earlier, it was indicated that the responsibilities in indoor air pollution at this time in 1984 are going to have to be transferred in large measure from the research community to the political community. If the community does not put pressure on those to whom the Office of Management and Budget listen, we will absolutely stop. There is already evidence in that direction.

1. Ventilation and money: a roof of concern

Figure 1 shows a plot of air change rates versus dollar cost. The data is not too particular but demonstrates fairly general assumptions. Our assumptions include system efficiency of about 80% at a cost of $7 per million BTU's for a 16,000 ft^3 of heated space, in either a 5000 or an 8000 degree day climate. Taking the milder climate, one air change per hour results in a cost in the range of $200 to $300 per year for ventilation. This is not trivial, and it has been the major drive in BPA's program. As we have seen in this meeting, there are many pollutants for which lower ventilation rates mean higher concentrations, since we cannot exclude every pollutant from our houses. So, carried to the extreme, much tighter houses would, in some cases, become health problem sources. We are talking about the central trade-off between public health and very large amounts of money to be spent unnecessarily.

2. What are the best ways to control indoor air pollution?

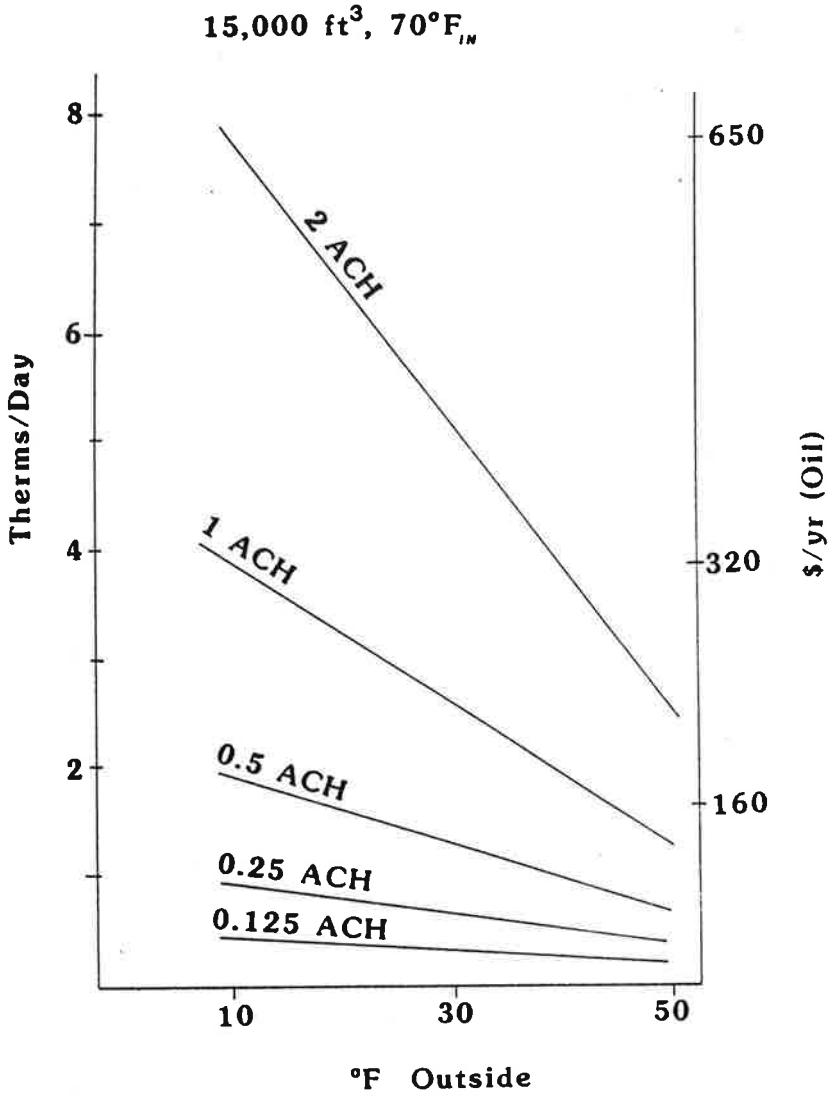

Figure 1

The general principles that have dominated our discussion over the last day and a half come straight out of industrial hygiene, but work as well for houses. In order of desirability, the best thing to do is: (1) keep the pollutant out; (2) seal the source, if it has to be in the building; (3) locally ventilate it, if it cannot be sealed; and (4) use general dilution as a last resort. The sub-slab depressurization discussed yesterday (Figure 2) to make sure radon never gets into the house is a good example of the first point. It is a lot easier to run a 52 cfm fan here than to add 100 to 200 cfm of dilution air to increase the general ventilation. This kind of solution is acceptable to the builders. As a second example, material substitution is extraordinarily important and something for which market drive can be expected to work, as long as the stick of litigation is always available. Dr. Meyer showed us how powerful this method

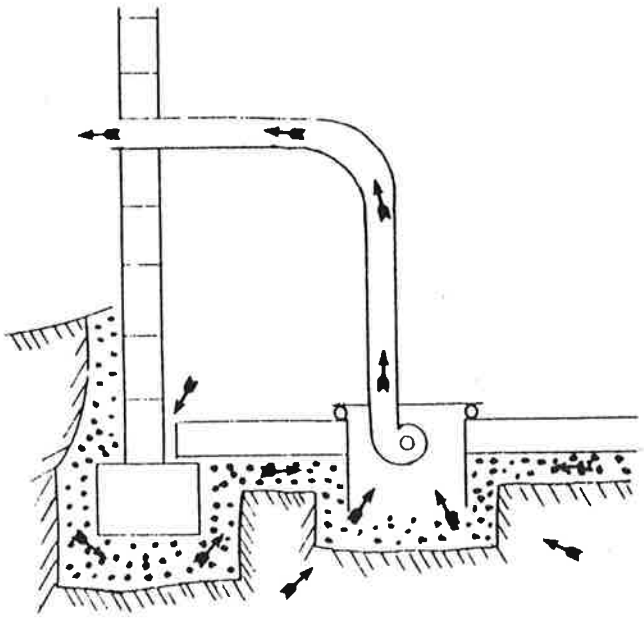

Figure 2

can be for formaldehyde. Small manufacturing changes can <u>eliminate</u> the problem. Consider some data from Matthews at Oak Ridge National Laboratory (Table 1). This shows the incredible range in emanation rates or emission rates of various materials, from 35 milligrams per square meter per hour for some forms of medium density fiberboard (MDF), down to almost immeasurable levels for other forms of plywood. We see, even within the tasks of building good cabinetry, one could select materials which are will not cause a problem. If a suspect material must be used, it can often be sealed. As a rule of thumb, good vapor barriers are frequently effective at lowering formaldehyde emissions. Our own kitchen cabinets were built of high-formaldehyde medium density particleboard. We sealed all surfaces with polyurethane varnish and oil-based paint, and have very low formaldehyde concentrations in the room.

The role of local ventilation is shown in the LBL data which show the relationship between nitrogen dioxide (NO_2) concentrations and air change rate. As we went from 0.25 to 7.0 ACH, we decreased the amount of NO_2 associated with a gas stove. Local ventilation is the easiest way to deal with this local (gas stove) problem. The LBL work points out if the range hood is as close to the stove as possible, it will take the least air and the most pollutants. Of course, lowering the vent hood is not always easy. Not only do consumers need to be convinced, but there are often important "actors": cabinetry is designed for high hoods, and will require re-thinking. In addition, some code officials may be uncomfortable with low-mount hoods. The good news may be that the

FORMALDEHYDE EMISSIONS, $mg/m^2\text{-}hr$

Medium Density Fiberboard (MDF)	35
Decorative Panels	0.8
Particleboard	0.2-0.3
Particleboard Decking	0.1-0.2
Plywood	< 0.1

(Matthews' Surface Emission Monitors)

Table 1

market could get driven in this direction by the desire to mount microwave ovens above the stove, and to have the oven low for access.

Do filters work? The recirculating filters based on activated charcoal is something which is pretty scary. If we cannot depend on people to change the oil in their cars, which are a large economic investment, and we cannot rely on them to change the filters in their furnaces, then we cannot rely on them to change the charcoal in their activated range hoods when there is no signal to tell them when to do that. On the other hand, electrostatic air filters or HEPA filters on major air circulating systems can be extremely effective solutions. They certainly can remove much of the dirt.

3. How much air is enough for ventilation?

General ventilation, as far as I am concerned, is a last resort. Still, a minimum general ventilation requirement is important because we cannot predict everything that happens in a house. Dave Grimsrud offered his opinion this morning that something on the order of half an air change per hour is a good start for building trades professionals. This assumes there are no large sources. Large sources could be formaldehyde emitters or a large radon problem, but it could also be the fact that there is no way we can design a ventilation system for a house which will adequately clean the air and dilute pollutants if all twelve members of the ladies bridge club come over one evening and light up cigars! There is no way a ventilation system can respond to that kind of source flow.

One point I want to emphasize which has not come out that strongly yet is that the ASHRAE recommendation of 5 cfm per person will correspond to concentration at steady state of about 2500 ppm of CO_2. In fact, historically, much of the literature has been driven by a desire to control CO_2. CO_2 turns out to be a good proxy for organics that you and I emit. Over a broad range of conditions, this corresponds to about 0.10 ACH. I personally feel that 2500 ppm CO_2 is not healthy at steady state. I would like to see continuous air change in a house, mechanically driven, with a minimum of 0.3 ACH. That would be an absolute minimum, contingent upon knowing that there are no extra materials in the house and that effective local ventilation, as per ASHRAE, are used. The ASHRAE recommendations are at least 50 cfm for the bathroom while in use, and 100 cfm for the kitchen while in use. If we do not feel consumers will accept that, perhaps we should stay above 0.5 ACH. I am reminded of Buffalo Homes in Butte, MT, who sell superinsulated houses, all with air-to-air heat exchangers. The wall switch they install has a three position control for these units: high, medium, and low. There is no "off" position.

4. How much do pollutants affect people?

People differ dramatically in their sensitivity to these

pollutants. We would assume without knowledge that people actually differ in their likelihood of developing lung cancer as a result of radon exposure. Certainly they differ in their sensitivity to formaldehyde. Some people seem to practically bathe in it, while others will feel irritation, headaches, and other symptoms when they just spot a sealed glass bottle. That people vary in individual thresholds in susceptibility consequently complicates those very important policy questions Dr. Meyer alluded to this morning. For whom do we regulate? The average person or the most sensitive? These are policy questions to which all of us have to be sensitive and with which we are not able to deal completely. To make this point, let's examine the data in Table 2. This is from Sam Syrotinski of the New York State Department of Health. He looked at some 1600 houses in New York which qualified by two factors for this study of formaldehyde in air. One factor was that there were health complaints in the house. The other was that the health complaint was attributed by the dwellers to urea-formaldehyde foam insulation (UFFI) which had been installed in the walls. These were houses which had both UFFI and health complaints. An important point here is not that 84 of these houses had less than 0.1 ppm of formaldehyde. To be sure, these data were collected some time after the installation. Still we are forced to ask whether this indicates that a large number of people are actually much more sensitive to formaldehyde than our present guidelines (e.g. 0.3 ppm) would indicate, or, alternately, if many of these health complaints are actually due to other antagonists or synergistic interactions between very low levels of formaldehyde and other pollutants in the house. I do not know what the answer is here. I do not like to say that we have no idea, but I think we have to be honest. These data are important for their indications that, despite all the mobile home experiences with concentrations of 0.3 to 0.6 ppm, we are now seeing health complaints, whether psychosomatic or physiological, among large numbers of people who are exposed to much lower levels of formaldehyde.

FORMALDEHYDE IN UFFI HOUSES WITH HEALTH COMPLAINTS

HCHO, ppm	Percent	Cumulative Percent
0.02	4.3	4.3
0.05	48.9	53.1
0.09	31.0	84.1
0.19	13.7	97.8
0.29	1.9	99.7
0.49	0.3	100

1621 Houses

Syrotinski, 1982

Table 2

5. Some notes on asbestos and risks.

Asbestos is very dangerous if you breath the fibers. On the other hand, it is a perfectly natural, relatively abundant mineral which long had a great many applications. Some of these were frivolous, but many were of great value to society. The EPA's quantitative risk estimates for populations with non-

occupational exposure require tremendous extrapolations of the concentrations and exposure histories of workers, down to that incidental exposure of students, teachers, and staff members in schools where there are sprayed-on asbestos ceilings. For this extrapolation (and other data), it seems that the risk over a lifetime for students, teachers, and staff members is very, very low. The most likely and the maximum estimates of the risk of developing lung cancer over a lifetime based on twelve years exposure in schools are in the range of a few tenths of a percent; risks which are very low relative to other risks in daily life. On the other hand, it is a risk that they are not voluntarily assuming, but to which the staff in involuntarily subjected.

There is also the synergistic effect to be considered as well. Table 3 is lung cancer incidence as a function of occupational exposure to asbestos where the control population was people exposed to similar dusts that were not asbestos. The workers were divided into two classes by another variable: whether or not they were smokers. Among the asbestos workers who have this terrible toll of illness today, some 80% were smokers. In this table, the non-smoking, non-asbestos worker has a mortality of one. We can see the gravity of the situation here; note that smoking without asbestos exposure is twice as dangerous as asbestos exposure at heavy occupational levels, without smoking. The combination, however, is fifty times as dangerous as either by itself as a cause of lung cancer! I want to stress the point that the likelihood of relatively strong synergistic effects among pollutants is something that we are not prepared to study yet.

SMOKING AND ASBESTOS

Asbestos Worker?	Cigarette Smoker?	Deaths per 100,000 person-yr.	Mortality Ratio
NO	NO	11.3	1
YES	NO	58.4	5.2
NO	YES	122.6	10.8
YES	YES	601.6	53.2

Hammond, et al., quoted in the Federal Register, 4 Nov., 1983, p. 51108.

Table 3

6. Who pays the piper?

At this time, as far as I have been able to determine, homeowners are on their own in solving indoor air pollution problems in houses. Most government agencies are ill-equipped to help. Even if competent private sector assistance can be located, it seems that there is little chance of recovery from either health or home insurance policies. There is a very vicious cycle here. Generally, in our society we have decided that it is not fair to expect an individual to assume all the risks of catastrophic

accidents. If we have a catastrophe, like a flood, we expect our government to try to help us. If someone trips on a defective stair in my home, I expect my homeowners insurance to defend me from litigation. This is the basis on which we buy insurance. Now, if I go to my insurance agent and say I discovered that I have 80 pCi/L of radon in my house, will he cover the cost of mitigation? This is the kind of rare risk catastrophe for which I want insurance, but most insurance policies exclude. Since they have no way to access the likelihood of a radiation problem, they have no actuarial basis. So it cannot be covered.

This has led to some very strong anomalies: The EPA has consented to bear much of the cost for cleaning up radioactive tailings which were used as foundation fill under a large number of houses, for example, in New Jersey. That's "technologically enhanced" radiation. The government helps us respond to that catastrophe. There are probably tens of thousands of houses in Eastern Pennsylvania with "natural" concentrations at least as high. The State of Pennsylvania does not want to know about it. The EPA has not been able to act on this. The insurance companies are not real happy to hear about it. So I am forced to conclude that we should prefer technologically enhanced radiation. The government will do something about it. But natural radon 222 cannot be dangerous, because nobody cares! There is a real irony here.

I am not blaming the insurance companies, because until we have a large scale national survey and a very strong consensus on risks and acceptable levels, we really do not have the actuarial basis they need for effective underwriting. It is one of the cases where the government must bear some responsibility, and I hope you will take that view.

7. Industrial hygiene and "sick buildings".

Industrial hygiene and non-industrial air pollution problems are very, very different from each other. The primary difference is the industrial hygienist is a marvelous person who has been trained to account for the concentrations of known pollutants in the workplace. He may be told that we have a certain amount of a specific suite of pollutants in the workplace. His job is to look up the appropriate methodology, measure how much there is, document the worker exposure, and make sure the employer is in compliance with regulations. Our problems in non-industrial indoor air pollution are different. Neither greater nor less, just different. Usually the non-industrial situation involves unknown antagonists, or environmental unknowns. "Why are people getting sick in this space?" For such situations, epidemiology, the study of fine and individual differences in episodes of illness, is critical. In our experience and the literature, chemical measurements rarely pinpoint the problem, but ventilation studies are often helpful.

8. Indoor Air Pollution vs. Outdoor Air Pollution

The impetus for indoor and outdoor pollution varies a great deal. This indoor air pollution problem is a very special kind of problem. Outdoors, our measurements are made either for research or for regulation. We are looking at environmental protection. Indoors, we do not yet know the distribution of any pollutant very well. We do not know how to respond to the public's demand that we assure health, or that we move toward efficient diagnostics. It is a different job, and we need some help. I called a friend on a congressional committee, who rapidly got for me a comparison of the EPA indoor and outdoor research budgets for air quality. It is embarrassing. Because Congress threatened a veto, the Office of Management and Budget (OMB) was forced to allow EPA to accept $2,000,000 for FY1985 to do indoor air pollution research. Including some other monies and some other agencies, the total federal budget for indoor air pollution is almost certainly less than $10,000,000 this year. The dedicated outdoor research budget (excluding compliance) for EPA this year is about $60,000,000. As we saw yesterday, we spend 80% to 90% of our time indoors, and only 10% to 20% of our time outdoors. If we take the U.S. population of about 240,000,000 and derive the equivalent full time person-years of exposure, we have about 190,000,000 person-years of indoor exposures per year and about 50,000,000 person-years of outdoor exposure per year. So we are now investing as a society something in excess of $1 per person-year in making sure we have research on clean outdoor air. That is important, because it will have a side effect of protecting the environment in general. But it is really absurd that our research budget for indoor air pollution and our supply of ventilation air for diluting indoor pollutants works out to a penny per person-year. I cannot fix that. Only you, as an aroused public demanding that the Office of Management and Budget be rational, can get us there. The lack of a few million dollars a year for indoor air pollution research is crippling an entire building industry and affecting productivity in many offices.

To summarize, please remember that most of these pollutants are at much higher concentrations indoors than outdoors. Our air pollution problems today are largely indoor problems. We rely on the Clean Air Act to provide us with clean outdoor air for dilution. It is important we maintain that for human health as well as environmental protection. But please, we must learn how to persuade the policy people that indoor pollution is not an invasion of privacy; it is an important component of the public health agenda.