

2354

Setting Standards for Recognizing Harmful Concentrations in Homes

B. Meyer, Ph.D.
University of Washington

Our comfort, welfare, and safety depends on the sum total of our environmental "bubble" (to use a recent regulatory term). The only standard that specifically addresses non-occupational indoor air concerns ozone and radiation, but indoor air quality is directly affected by standards in many other fields, such as by ambient air standards, occupational air quality standards, regulations regarding occupancy, building codes, smoking regulations, ventilation, energy conservation, product standards, building temperature regulations, and so forth. Some of these are federal regulations, some are state or local level government regulations, and some are voluntary regulations or only voluntary guidelines. The setting of such standards involves many factors.

Whether one should set standards, how far standards should go, and how such standards should be implemented are emotional topics. In some cultures, the leaders are responsible for all aspects of their subjects' lives; in others, everybody is on his own. Under our current form of government, with public schools and public education, there seems to be agreement that people should be equipped to inform themselves, or perhaps, even that they have a right to be informed.

ASHRAE standard 55-1981 provides for a physical comfort range of 20-60% relative humidity (RH), 68-81 F, and an air velocity of 20-50 feet per minute, but when, in 1979, President Carter used his executive power to implement Emergency Building Temperature Regulations to set thermostats at 68° F in winter and 72° F in summer, his order was not well received. I guess many of us believe in individual freedom. Speaking for myself, I'm basically a conservative and I prefer voluntary action, as far as possible. However, I have worked as a federal employee for the Consumer Product Safety Commission (CPSC) and with this experience, I have gained certain reservations about leaving consumer products entirely to voluntary regulation. Now there are people who argue that this is a free country and there is no need for any product standards whatsoever. The argument is that anybody who doesn't like what he buys can go and sue. This is a free country, we can sue anyone we want. However, there are several problems with this approach, and if one reviews various product histories, one will find that most manufacturers in most industries strongly support product and material standards, because they tend to favor quality levels that are necessary to make products successful in the long term. But standards are useless if they are not enforced. This presents a series of difficult problems in the indoor air environment, because few people would like to have government inspectors visit their homes, and revive the time when social agencies visited welfare

families at 6 a.m. to conduct bed checks.

There are several regulatory concerns that affect indoor air, and regulating indoor air is not new. Ventilation in school rooms has been regulated since the pioneering studies of John Griscom, a New York surgeon. Occupational concern goes back far further, because we know that Egyptian masons used dust masks as protection against dust, and asbestos cancer was clearly demonstrated by L. Smith in 1935. Furthermore, during the past century most states had anti-smoking laws to prevent fire.

Which federal agencies are currently involved? The Consumer Product Safety Commission deals with consumer products and architectural materials. The Department of Energy (DOE) is concerned with energy conservation. The Environmental Protection Agency (EPA) is in charge of ambient outdoor air and has studied the indoor air field for a long time. In 1972 to 1974 the Department of Housing and Urban Development (HUD) published a series of outstanding indoor air quality reports. At that time, the idea was that indoor air was cleaner than outdoor air. The National Institute for Occupational Safety and Health (NIOSH), finally, is responsible for air quality at the workplace.

If one considers the mandates of these agencies, it does not astonish that they have not always had the same goals. In fact, it is the very purpose of this set-up to provide a reasonable balance between the interests of the various population groups these agencies serve. To give only one example, in the residential conservation field, the Department of Energy has a strong mandate to use the best available insulation technology. Thus, DOE in the U.S., and especially in Canada, has always promoted new materials, such as urea-formaldehyde foam insulation (UFFI). In contrast, CPSC has been more concerned about quality and safety, while HUD has to promote affordable housing for everyone. Obviously, the best available technology may be in conflict with the goals of affordable housing for everyone. Thus, if one looks at the regulation of August 9, 1984, HUD is not charged with the health of people. It is charged with providing shelter. In contrast, CPSC would like the lowest possible formaldehyde level to insure safety. This level would be at the natural ambient level in urban areas, say, 0.1 or 0.05 ppm. NIOSH is responsible for the health of the working population. This restricts NIOSH to concern for reasonably healthy people. NIOSH has conducted over 200 investigations of indoor air complaints. They found no problems, because NIOSH would violate its mandate if it would concern itself with non-occupational levels. It could be argued as a violation of the law if NIOSH would spend its money on developing 0.1 ppm formaldehyde monitoring equipment, when the OSHA workplace level is still 3 ppm, at least as long as the NIOSH recommended formaldehyde level of 1 ppm has not been accepted by the Department of Health and Human Services (HHS). [However, on April 17, 1985, OSHA solicited public comments whether 3 ppm is too high, even in the work place.]

How are standards set? In this country, we have a very healthy, often openly adversary method of setting standards. The history of standards is long and successful. Basically, our government relies on a voluntary process, consensus standards. There are elaborate, well established procedures, validation programs that are published for review and public comment long before any decisions are discussed. If new problems arise, standard setting bodies heavily rely on related standards in established fields; say, when public bodies want to protect air quality in public places, they rely on occupational experience. However, as stated, occupational laws are specifically for the healthy, working population and the Occupational Safety and Health Administration (OSHA) wants acceptable standards very much the way HUD wants acceptable housing. The first goal is to promote commerce and jobs. Comfort is a luxury. OSHA and NIOSH have no obligation to protect highly sensitive people against allergies, because, if a worker is overly sensitive, he can ask for a transfer or he can quit. This is quite different in the case of students or homemakers, old people or children. Thus, translating OSHA or NIOSH standards into the home environment immediately brings a whole new set of problems. There are established procedures for computing such levels. I will discuss these in a minute, but first I wish to add that there is quite substantial law case in the State of Washington on that subject. There was recently a Washington State Supreme Court decision in a formaldehyde case. While individual states vary substantially, in the State of Washington a manufacturer does not have an obligation to protect absolutely every person. If someone is hypersensitive, he cannot buy a home and then claim that it should have been suitable for everybody. The question is whether it is a product advertised for general use or for whom it is advertised.

The question is now how to find reasonable standards. I would like to use the ventilation standard for acceptable indoor air quality of the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) as an example. ASHRAE is a member of the American National Standards Institute (ANSI) and follows the latter's consensus procedures. It takes ASHRAE some seven years and some fourteen meetings and long correspondence among the dozen of panelists from industry, academia, and consumers to come up with a proposal that is ready for public comment and vote. The resulting standard is then a guideline that becomes mandatory only if it is incorporated into building codes. Each revision needs to be incorporated anew. Thus, currently, most building codes still rely on ASHRAE 62-1974, rather than ASHRAE 62-1981.

What air levels did ASHRAE 62-1981 choose? ASHRAE used recognized occupational levels and adjusted by a factor of ten. One third of this is due to providing coverage for people who are in offices and public places and are more sensitive than chemical industry workers. Another third is due to the longer exposures that people may experience in non-manufacturing buildings. The resulting levels often coincide with levels set by the U.S. Navy

for submarine crews, by the U.S. Air Force for cockpit air quality, and by NASA for space craft. Thus, when ASHRAE decided that formaldehyde should be explicitly listed among contaminants, it did not arbitrarily set some new level. It merely adopted a level long used by others. The method is the same as that often used by EPA.

EPA is charged with dealing with the general population and with providing appropriate levels to take care of people beyond the healthy working population in public places. There are established ways of doing that for outdoor air. First of all, to cover children and old people, a safety factor of three or four is used in translating the minimum acceptable OSHA levels. Then we have time-weighted averaging. If I understand it correctly, EPA now promotes new ideas. It used to be that there were regional, source measuring stations, say downwind from a plant. Under the current bubble concept, sources are regionally averaged and integrated into a "bubble". Also, EPA now accepts the concept of individual personal exposure. Thus, for setting an indoor air standard, one needs to follow people for the full day, i.e. 24 hours. Total exposure is the sum of work exposure, exposure in transit, and exposure at home. Since, even for spouses, the total individual exposure may differ tremendously, every person has to manage his own safety individually. A homemaker may have a tenfold higher or lower exposure than the working spouse who is home only at night and may hardly enter the kitchen. Therefore, pollutant concentrations, by themselves, are of limited value, in my opinion. This brings up the problem of enforceability of indoor air standards. One cannot easily forbid smoking in private homes. Even in the office environment some people say that existing carbon monoxide standards are sufficient for smoking regulation. It has been said that carbon monoxide levels are exceeded in most smoking areas and therefore all one needs is to reinforce carbon monoxide standards and smoke will be excluded. This is an example of a non-enforceable standard, since it would require very good knowledge of carbon monoxide levels at breathing levels of all people in a room, because cigarette smoke does not mix readily with air and levels downwind from a smoker are far higher than average values.

Radon presents another type of problem. In the case of radon, occupational levels have been observed in some homes, but we do not know levels in all homes. Should the government measure radon levels in some seventy million residences to insure safety for the few hundred families that are at unreasonable risk? Or should measurement be optional, or at the individual's own initiative, or expense? What if a building material has been recognized as a source? I will later argue in behalf of mandatory disclosure of formaldehyde emission; but should this apply to all indoor air pollutants?

Another question concerns what should be regulated: air concentrations or exposure levels or doses? We are the only large, industrialized country with 3 ppm occupational formaldehyde ceiling levels. All others have levels of about 1

ppm or even less. How does this translate into exposure levels? 3 ppm during an 8 hour workday adds up to 3 ppm times 8 hours, i.e. 24 ppm-hours. Assuming a sedentary person breaths ten cubic meters of air per day, this amounts to about 100 mg formaldehyde that is absorbed in the human respiratory tract during a work day. Now if someone were living in a home with the same level for 24 hours, e.g. he or she were sick and in bed, the exposure would be 3 ppm x 24 hr = 72 ppm-hr. Likewise, a time weighted average industrial exposure upper limit of 3 ppm x 8 hrs = 24 ppm-hr would translate to 1 ppm x 24 hr = 24 ppm-hr. Translated into seven day average dose it would be 0.71 because people don't work Saturday and Sunday. Now, obviously most homemakers aren't home 24 hours, so let us assume they are home on the order of 20 hours (and amazingly enough most people who are homemakers are home 20 hours regardless whether they live in Russia, in the Tropics, or in the United States). Then the weekly average dose would be 0.83 ppm; for babies or somebody who is confined, 1.00 ppm. This is half a gram of formaldehyde per week. Such levels have indeed been observed in some mobile homes containing defective products.

Normal, ambient air contains less than 0.05 ppm. The absolute odor threshold is 0.05 ppm. The ASHRAE standard 62-1981 is 0.1 ppm. The same value applies for U.S. Navy submarines and NASA spacecraft. ASHRAE doesn't concern itself with health; it concerns itself with comfort. There is still controversy about the threshold value for health effects, but it seems reasonable to set standards that are not lower than ambient air levels. On the other hand, the HUD level for mobile homes is now 0.4 ppm at the time of sale, and at 77° F and 50% RH. If such new homes are placed in hot areas, formaldehyde levels may increase substantially and cause serious complaints.

How should one set a reasonable level? A reasonable level depends not only on health or comfort, but also on cost. In the case of formaldehyde, since HUD set a 0.4 ppm value, products have become available that yield less than 0.1 ppm under normal use conditions, at no, or very little, extra cost. Thus, higher levels are no longer necessary today, and it seems reasonable to restrict levels to outdoor ambient values. How about other indoor air pollutants? Where possible, outdoor ambient EPA levels seem the most reasonable. For chemicals that are regulated in the occupational environment by NIOSH/OSHA, the customary 10% choice is well established and appropriate in order to compensate for large residential exposures, and in order to cover a wider segment of society. However, there are some exceptions.

The situation with asbestos is not yet clear. One does not yet know how to reduce asbestos in private residences without the risk of inadvertent spreading of particulates; in schools the removal may be equally tricky, and still prohibitively expensive. There are widely divergent opinions about the regulation of smoking, but it has been established that non-smokers may be exposed to levels that are comparable to those of smokers.

Another problem is that smoke does not always mix with indoor air, and those down-wind may experience higher than average exposure levels. Finally, there are pollutants, such as the nitrogen oxides, that are very difficult to avoid if natural gas is burned. In such cases, it might be easier to offer optional substitution of gas by electricity for kitchen appliances, than to develop standards that are either unreasonably expensive for those who do not suffer, or insufficient for those who are sensitive, or maybe both.

QUESTION: Why are formaldehyde standards for mobile homes not reduced to lower values?

ANSWER: We are going through an interesting, intermediate period. Most large mobile home dealers currently buy particleboard only if the manufacturer guarantees to pay legal fees. Thus, we presently have in new mobile homes a lot of truly outstanding materials with very low emissions, because the threat of impending regulation and competition, i.e. free enterprise, produced a better product. Problems arise when regulatory agencies set standards before products have reached maturity. When HUD decided on a 0.4 ppm standard, it was economically reasonable. Today, it seems excessively high, but it is not yet certain whether manufacturers will fully implement new technology if the regulatory pressure fades away and low formaldehyde emission is no longer a commercial factor in competition. Thus, there is now a real possibility that formaldehyde levels are going to climb up within the next two to three years.

QUESTION: You said in a couple years this problem will increase. It will get in the public eye. Won't that force the manufacturers to go back and make the better particleboard then?

ANSWER: I'm glad you asked that. I might sound to you like being an adversary of industry; I'm actually not. Industry would love to implement good materials and then stand by them. But it's very difficult for someone to do that under the current economic pressure unless people specifically ask for a good product. So if all of you and all of your friends ask for emission level disclosure in building products, the issue will become competitive argument. As is, particleboard is still sold as a commodity out of pools. Everybody gets his material through the same outlet, and he who produces the cheapest board makes the highest profit. If we start asking for brand names by emission levels then those who make low-fuming particleboard are going to sell more and they're going to make a bigger profit and they are going to be delighted.