LETTERS

Indoor Air Pollution

We wish to commend John D. Spengler and Ken Sexton for their excellent article on indoor air pollution (1 July, p. 9). At the State of West Virginia Department of Health, we are faced with an accelerating number of complaints in this area. Our investigations to date suggest that the majority of these situations reflect exposures of toxicological significance. Unlike the relatively well-endowed programs established to deal with contaminants or pollutants in the other environmental media, our indoor air quality work has had to proceed without the benefit of special funding. Additional funds for both specialized research and general public health efforts are clearly needed.

We do take exception to one policy implication suggested by Spengler and Sexton. They appear to be recommending that regulatory action governing indoor air quality be held in abeyance until the issues involved are better understood. While this point is well taken in regard to many indoor air contaminants, action on other well-documented health hazards should not be delayed pending this research. Considerable data are already available on some sources of indoor air contamination showing widespread exposure to concentrations representing a serious health risk. There are often practicable control measures available at a reasonable cost that can reduce these exposures to a relatively safe level. One such example is formaldehyde in mobile homes. Another example is chlordane fumes in homes that have been treated for termite control.

Prudent public health policy should include regulatory action to control these established health hazards as expeditiously as possible. Such action should proceed simultaneously with research efforts to better define indoor air health-related phenomena in general.

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The fine article on indoor air quality in nonoccupational settings by Spengler and Sexton makes no reference to pentachlorophenol (PCP, "penta"). PCP is an important pollutant that poses a significant, but largely overlooked, threat to the public health. It is widely used as a pesticide, especially in the treatment of lumber.

Ample documentation exists that PCP can contaminate the ambient air in wooden houses. The increasing use of wood-burning stoves, especially in homes with reduced air-exchange rates, may intensify such exposure when PCP-treated lumber is used. A case in point involves burning "surplus" PCP-treated lumber intended for the storage of munitions.

The Environmental Protection Agency has stated that "the application of penta formulations or use of penta-treated wood in homes may result in penta air levels which exceed levels detected in many commercial settings" (*1*). These observations are pertinent: (i) PCP concentrations up to 1800 parts per billion in the ambient air of log cabins have been recorded; and (ii) 6 months after PCP treatment, the chemical remains on wood surface in concentrations approximating 0.5 milligram per square foot.

Other aspects of inhaled PCP underscore its potentially serious nature.

- The EPA arbitrarily considers PCP to be 100 percent absorbed by inhalation in "worst-case" situations. This contrasts with its estimate of 10 percent absorption from the skin.
- PCP continues to vaporize from treated wood even after several years.
- Paints (both oil- and water-based) do not eliminate the volatilization of PCP from pressure-treated wood.
- There is significant "blooming" of PCP. Such vaporization of crystalline penta as dust particles further increases exposure.

I have reported serious hematologic damage in the form of aplastic anemia and pure red cell aplasia after prolonged exposure to PCP (*2*). It also has potential fetotoxic, mutagenic, oncogenic, and teratogenic effects, as do the other chemicals that contaminate commercial PCP. Considerable amounts of chlorinated dibenzo-*p*-dioxin and dibenzofuran are present in commercial-grade PCP manufactured in the United States (*3*).

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References

1. *Wood Preservative Pesticides: Creosote, Inorganic Arsenicals, Pentachlorophenol* (Position Document No. 2/3, Environmental Protection Agency, Washington, D.C., January 1981).
2. H. J. Roberts, *N. Engl. J. Med.* **305**, 1650 (1981); *South. Med. J.* **76**, 45 (1983).
3. C. Rappe and H. R. Buser, *Chemical Hazards in the Workplace—Measurement and Control* (ACS Symposium Series, No. 149, American Chemical Society, Washington, D.C., 1981), p. 319.

Aaroe and Light suggest that sufficient information now exists to justify government regulatory action for some indoor contaminants, specifically formaldehyde and chlordane. They imply that our article contends that regulatory action governing indoor environments be held in abeyance until the issues involved are better understood. It is our opinion that health evidence to substantiate indoor air quality standards for public or private dwellings is not available. This does not imply that government intervention or regulation should be held in abeyance. Regulatory action can be justified if it is predicated on ameliorating health risks by reducing human exposures. There are, in fact, several examples pertinent to indoor environments of governmental intervention founded on this principle, namely, the banning by several states of urea-formaldehyde foam insulation, the Food and Drug Administration's emission standard for ozone from office machines, and the Environmental Protection Agency's (EPA's) asbestos program. While there are no federal indoor air quality standards applicable to home and public buildings for asbestos fibers, intervention in the form of containment or removal is justified where there is a probable risk of exposure. Unfortunately, reasonableness has not been uniformly applied in the school asbestos situation.

Residential use of pesticides and insecticides is a difficult area of indoor air quality regulation. In recent years, indoor residential concentrations of the termiticide chlordane have exceeded the National Academy of Sciences's guideline of 5 micrograms per cubic meter as a result of improper application or construction defects (*1*). However, EPA still permits the use of chlordane although it is a known carcinogen (*2*). These decisions do not inhibit states from regulating the use of domestic insecticides. In fact, the Commonwealth of Massachusetts has restricted the application of chlordane (*3*).

We stated in our article that "creation of a regulatory framework for indoor air quality poses special policy issues which bear directly on choices about appropriate public responses." Policy-makers and regulatory agencies should realize that indoor air is not necessarily in the public domain, especially in private dwellings. Sexton and Repetto (*4*) note that households are already making decisions about their own air quality. Regulators might or might not improve the decisions made in these households, although the case is stronger for government intervention in public and privately owned buildings, where building management affects ventilation or materials used indoors, or both.

We stated that "the mounting evidence of elevated indoor contaminant levels suggests that government efforts to safeguard citizens' health and safety may be justified." However, we took pains to emphasize that the issue is not just whether or not public actions are needed but also what modes of intervention are appropriate. Public agency response to unhealthful indoor air could be varied, including ignoring the problem, funding research, leaving it to personal choice (such as for saccharin and cigarettes), expanding administrative efforts on the basis of existing legislation, using moral suasion by public education efforts, defining legal liabilities, instituting fiscal incentives (such as taxes, fees, and subsidies), and promoting new rules and regulations.

We point out that, even if adequate health data existed, indoor air quality standards would be impractical and especially difficult to enforce in 82 million residences. Restricting sources, certification of "safe" concentrations, and disclosure of possible sources upon transfer of ownership may be government actions preferable to setting indoor air quality standards. As examples, the Swedish government has established "action levels" for radon in existing or new homes. It would be reasonable for the U.S. Department of Housing and Urban Development or local governments to include indoor air quality considerations as a criterion for occupancy permits, in much the same way that sanitation, structural, and electrical conditions are included.

The letter from Aaroe and Light underscores the problems faced by state health officials in dealing with indoor air quality problems. Most states lack the authority, funding, and expertise to address the issue adequately. One of us (K.S.) is director of the first, and so far only, state program devoted exclusively to investigating indoor air quality in nonindustrial environments. However, as awareness about indoor air pollution increases among scientists, engineers, regulatory officials, and environmental groups, it is likely that similar efforts will be spawned at local, state, and federal levels of government.

The comments by Roberts about adverse health consequences of indoor exposures to pentachlorophenol (PCP) are well taken. A potential health hazard in a new state office building in which interior wood had been impregnated with PCP was identified recently in Long Beach, California. The problem was noted before occupancy, and the PCP-impregnated wood was covered with a sealant to reduce emissions.

The California Department of Health Services undertook a study in this building to ensure that remedial actions were adequate to protect occupants' health (*5*). Indoor air measurements of PCP were combined with body burden monitoring (PCP in urine) to assess the relation between exposure and response for a subset of building occupants. It was established that body burden was related to measured environmental exposure.

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References and Notes

1. Committee on Toxicology, Board on Toxicology and Environmental Health Hazards, National Research Council, *Seven Pesticides Used for Termite Control* (National Academy Press, Washington D.C., 1982).
2. Office of Pesticides Program, *Comparative Benefit Analysis of Seven Chemicals Registered for Use Against Subterranean Termites* (Environmental Protection Agency, Washington, D.C., 1981).
3. "Minutes" (Pesticide Board Subcommittee, Department of Food and Agriculture, Commonwealth of Massachusetts, 1 March 1983); *ibid.*, 18 April 1983.
4. K. Sexton and R. Repetto, *Environ. Int.* **8**, 5 (1982).
5. J. J. Wesolowski, K. Sexton, K. Liu, P. Flessel, S. Twiss, in preparation.

Factoring

In "Factoring gets easier" (Research News, 2 Dec., p. 999), Gina Kolata conveys very clearly the sense of excitement surrounding factoring large numbers today. She also makes the significant observation that there is a common denominator to the accomplishments of Davis and Holdridge, of Wagstaff and Smith, and of Wunderlich, namely, that these researchers have capitalized on the architecture of the computers on which they work to achieve either substantial improvements in the speed of factoring or in the size of the numbers that can be factored. While this is both true and newsworthy, it is equally true that the algorithms themselves, that is, the procedures used to factor numbers, have experienced a corresponding development that has made it possible to exploit the computer architectures. For example, Kolata points out that there are two competing primary factoring algorithms: the continued fraction technique, largely due in its present form to Mike Morrison and John Brillhart, and the quadratic sieving technique discovered by Carl Pomerance as an improvement of an earlier sieving algorithm developed by Richard Schroeppel. The recent history of factoring can be viewed as much as a competition between these algorithms as a competition between the various computer architectures. The continued fraction algorithm is reasonably well adapted to being implemented on conventional computers in the CFRAC code. Consequently CFRAC was the most efficient general-purpose factoring algorithm available at the time that the Cunningham Project Table was completed. The sieving operations required to efficiently implement Pomerance's algorithm, however, while not so well matched to most computers, were ideally suited to the vector processing (operations that permit entire vectors to be processed as units) capability of the Cray computer. This explains in part the roughly 100-fold speed improvement in factoring achieved at the Sandia National Laboratory in 1983. The story doesn't end there; for while the continued fraction algorithm was reasonably well matched to conventional computer architectures, it is even better matched to the architecture of the highly parallel machines such as the DAP or the MPP (Massively Parallel Process) on which Wunderlich is currently working. Hence the expectation that the speed advantage will shift back once again to the continued fraction algorithm, with continued improvements in the algorithm itself. The final outcome cannot even be guessed at this point, but it is probably true that the lead in the machine-algorithm competition will shift back and forth several more times and perhaps to some as yet undiscovered marriage of machine organization and algorithm.

What has been achieved in factoring results from a remarkable marriage of algorithm design and machine architectures that appears to be characteristic of what is happening in the computer treatment of any number of mathematical problems that are on the edge of computational feasibility.

As a postscript: Davis and Holdridge have just broken their previous records by factoring the 67-digit hard part of the Cunningham number $11^{102} + 1$ in only 13.7 hours!

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