Indoor Air Quality Update™

A Guide to the Practical Control of Indoor Air Problems, from Cutter Information Corp.

Vol. 2, No. 4 Hal Levin, Editor April 1989

Federal IAQ Act of 1989 Introduced

On March 21, Senator George Mitchell (D-ME) and 18 Senate colleagues introduced a carbon copy of Mitchell's 1988 IAQ legislative proposal. The bill made it out of committee in 1988 but was never taken up on the floor. Considering Mitchell's new position as Senate majority leader, chances are good that the bill will move through the process more easily this year.

The new bill, S. 657, establishes a wide variety of detailed programs. We summarize those programs and comment on some of them below. The bill is a major step toward recognizing indoor air as a significant national environmental and public health problem. The bill is quite ambitious; the authorized $48.5 million may be insufficient to accomplish all that the bill requires.

We need a significantly expanded federal IAQ effort. However, if EPA and other federal agencies expand their activities too quickly, efficiency and effectiveness will suffer. The rapid development of the radon program demonstrates that when the need is perceived, a large and effective effort can be quickly mounted. The case of asbestos, however, shows how Congress can mandate action but not adequately fund it; the results are less than satisfactory, according to many observers.

Many federal agencies engage in research activities related directly or indirectly to indoor air. The most important area for new federal activity is the health sciences. More IAQ research funding at some of the national institutes of health could do much to improve our understanding of IAQ health effects. The research methods and personnel are there to respond if funding priorities are set to encourage work on indoor air health issues.

Of course, federal budget politics do not support proposals for large (and costly) new programs. Other more established environmental issues have suffered from inadequate funding for many years. Acid rain, toxic waste cleanup, clean air, and disaster (oil spill) response are still important agenda items in Washington.

Key Provisions of the Bill

Research

The bill mandates a broad range of research activities. The research program will study the following aspects of indoor air contamination:

- Health effects;
- Exposure assessment;
- Identification of populations at increased risk of illness;
- Characterization of the increased risk;
- Characterization of exposure in different building types;
- Identification of building types or design features which increase the likelihood of exposure;
- Assessment of nonindustrial worker exposure and health effects;
- Source identification; and
- Assessment of indoor-outdoor concentration relationships.

In This Issue

The research program will also include studies to:

- Develop methods for characterizing and modeling indoor air movement;
- Assess the environmental fate of contaminants;
- Develop methods for characterizing the relationship between contaminants in indoor air and climate, location, seasonal change, soil, and site geology;
- Assess IAQ in schools and measures to control contaminants in such buildings;
- Develop methods and instruments for sampling indoor air, including low-cost, easy-to-use instruments accessible to the general public; and
- Develop materials and products that may be used as alternatives to indoor air contaminant sources.

A technology demonstration program will fund up to 75% of project costs. The program will favor projects that may effectively control sources or potential sources of contaminants dangerous to human health. Projects with wide applicability will also be favored. Grants will be awarded annually.

The research program will publish bulletins that assess technologies and management practices for the control and measurement of contaminants in indoor air.

The bill calls for radon monitoring protocols for child care facilities within six months of the bill's enactment. The protocols will go to appropriate state agencies. The EPA will also undertake radon diagnostic and remedial efforts in nonresidential child care facilities. These efforts will lead to the development of methods which can be used widely.

The bill also requires the program to make a report to Congress on the extent and seriousness of indoor air contamination in schools within two years.

Health Advisories

A fundamental question about exposure to indoor air contaminants is whether adverse health effects are likely. The health advisory requirement, along with the research program, responds to the need for answers. Within 240 days of enactment, EPA will publish a list of contaminants that occur in indoor air. This list will be reviewed and revised at least biennially. The bill provides for public review and comment on the list before publication.

The list will not be considered rulemaking. This will make it easier to list a substance; there will be no burden of findings or evidence. Also, absence from the list will not indicate that a substance is safe or free of adverse human health effects. States may apply to have individual contaminants added to the list.

EPA will publish advisories about the adverse health effects of individual contaminants on the list. The advisories will describe:

- The contaminants' characteristics;
- Adverse human health effects;
- Risks associated with various levels of the contaminants;
- Threshold levels for no known human health effects;
- Specific sources of contaminants and their emission rates; and
- Any standards or related action levels in effect under state or federal law.

The advisories will help the public understand the range of risks of exposure to indoor air contaminants. They will be written so the general public can understand them. Six advisories will be required within 18 months of enactment, and six more within 36 months. The program will revise published advisories every five years. Public review and comment will precede publication of the advisories.

The Indoor Air Panel of the EPA Science Advisory Board will guide the development of the health advisories. That group will advise on the priority of contaminants as health advisory subjects and on the content and quality of the advisories.

The Mitchell bill provides the research program and the health advisories $20 million per year for five years. This is a paltry sum considering the scope of the legislative mandate and the nature of the beast. So little is understood about so many of the hundreds of indoor air contaminants of potential significance. Yet, two elements of the legislation are the keys to real progress: the research, in order to gain an understanding of the problems, and the health advisories, in order to develop a basis for identifying and evaluating methods to control indoor air quality.

Senate staff consider the health advisories an important component of the program. The advisories will drive much of the bill's implementation and will lay the foundation for the future of indoor air research, regulation, and private sector response. However, the pro-

gram is not sufficiently funded to do the kind of work needed to implement this part of the bill.

Representative Claudine Schneider (R-RI), lead Republican co-sponsor in the House and the ranking Republican member of the Natural Resources Subcommittee of the Science, Space and Technology Committee, is likely to push for an overhaul of the health advisories provisions. Her committee authorizes all of EPA's research and will probably hold hearings this summer, according to sources close to Rep. Schneider.

When Rep. Joseph Kennedy (D-MA), introduced the House version of the Mitchell bill on March 21, Rep. Schneider indicated that she will work for changes in the health advisory requirements. She is likely to push for unambiguous, but "realistic," action levels — although health based, they must be feasible. She will also push for the incorporation of specific solutions into any health advisory. On the House floor, she presented her concerns and intentions as follows:

"Industries who are willing to do their part have pointed to certain approaches that would assist them in complying with such guidance. First, they seek clarity in the targets set out by the agency. Action levels for different contaminants should be specific in order to minimize uncertainty regarding what is expected from remediation.

"Second, there should be established a reasonable process by which the action level is set. Recommended action levels should be based on concentrations that do not present a significant risk to health. At the same time, however, the action level should be one that realistically can be achieved. For example, the air quality indoors should not be expected to exceed the quality of air found outdoors. Furthermore, interested parties should have ample opportunity to contribute to the recommendation process.

"Finally, the issuance of any recommended action levels for a particular contaminant should be accompanied by practical information regarding the remediation technologies and options that are available. A fairly successful model for the agency to follow is the radon program, which has been widely credited not only for bringing the public attention to the serious threat of radon, but with providing useful information for the person who wants to correct it."

Sources close to Schneider indicate that industry is going to ask for protection from liability, and that it is willing to act responsibly if the rules are made clear. Radon is considered a "good" example, and asbestos is considered a "bad" example, of how this sort of issue has been handled in the past. There is a strong sense that we do not know enough scientifically to regulate; therefore, we should protect industries willing to make a good-faith effort.

National IAQ Response Plan

The bill also requires that EPA, in consultation with appropriate federal agencies, develop and publish a national indoor air quality response plan. Some of these requirements call for little more than dissemination of information developed under the research section. However, the response plan will also identify contaminants requiring action to protect public health [read that "regulation"], the statutory basis for such action, the implementing federal agency, the financial resources needed, and the indoor air contaminants for which concentration reduction requires developing further technology.

The response plan is due to Congress within 24 months of enactment of the legislation.

Comment

We have little faith in the development of an effective, comprehensive response plan at the federal level. In our view, that would involve recognizing that indoor air poses more serious threats to public health than outdoor air or many other environmental problems that are far more heavily researched, regulated, and financed. An effective effort requires a radical increase in funding of indoor air research and technical assistance, perhaps ten times what the Mitchell bill requests.

Even if Congress wanted to provide such funding, the federal government is not prepared to administer such an increase in activity at this time. However, implementing the health advisory and response plan provisions will generate more understanding and awareness of the significance of indoor air contaminants. This might eventually lead to a better funding level and federal role in assessing and controlling indoor air contaminants.

The IAQ issue has not matured politically, legally, technologically, or financially. The Bush Administration has not yet shown a willingness to tackle environmental issues aggressively. The position of OMB on the EPA Report to Congress will be a bellweather; but even strong support of the draft will not guarantee a reversal

of past and present realities at EPA. OMB's position will be necessary soon, since EPA can hardly testify on the Mitchell bill without discussing the Report to Congress. We covered this topic in last month's issue (*IAQU*, March 1989).

Federal Building Response Plan

The bill requires the administrator of the General Services Administration and the administrator of EPA to develop a response plan and demonstration program in federal buildings. The federal building response plan will include:

- Actions and guidelines for general management practices;
- Product purchase guidelines;
- Air quality problem identification practices and methods;
- Personnel training programs; and
- Other actions to reduce exposures to indoor air contaminants.

The response plan also includes identifying federal buildings where indoor air contamination is sufficient to justify assessment by NIOSH, and planning for corrective actions. The plan will fund NIOSH investigations as part of a $5 million per year authorization for NIOSH investigations of federal, state, and municipal buildings. (Note the omission of privately owned buildings.)

Under the federal response plan requirements of the bill, federal workers and the public will be able to file complaints on indoor air quality in federal buildings with the General Services Administration (GSA). The filings will be available to the public, according to our reading of the bill.

One-half of one percent of funds appropriated for new federal building construction will pay for measures to reduce indoor air contaminant concentrations within such buildings. These measures may include developing design measures, improved ventilation techniques or equipment, product purchasing guidelines, contaminant detection and response systems, and building management guidelines and practices; and training building management and maintenance personnel in building and systems operations.

The bill requires that the new EPA headquarters building in Washington be designed, constructed, maintained, and operated as a model to demonstrate principles and practices for protecting indoor air quality. [*IAQU* editor Hal Levin is an indoor air quality consultant to EPA on the requirements for the design of the new building.] GSA is now reviewing EPA's building proposal. The building plan is the first attempt to implement ASHRAE's revised ventilation standard and to develop strict guidelines for building material and product selection. If GSA approves EPA's proposal, the building will pave the way for many IAQ innovations.

The bill authorizes $2 million per year for the federal response plan.

State and Local Indoor Air Quality Programs

States may apply for grants to support demonstration programs for management strategies and for assessing IAQ within the state. These programs allow the states to develop information for health advisories, particularly the setting of action levels, guidance, or standards. Grants under this section may not be less than $75,000 per year.

States or local air pollution control officers may apply for grants to help develop response programs that reduce human exposure to indoor air contaminants. These plans must address contaminants on the previously discussed federal list. Grants under this section may not exceed $250,000 per year for a maximum of three years; the federal share cannot exceed 75% of the total program cost.

$12 million per year is authorized for the entire state and local grants program. One-third of the funds would be reserved for the state and local response programs.

Office of Indoor Air Quality

A new Office of Indoor Air Quality within the Office of Air and Radiation will implement many of the EPA programs. (Currently, EPA has a Division of Indoor Air in the Office of Air and Radiation.) The change in status from Division to Office means an increase in staffing to not less than ten permanent full-time employees and a permanent full-time employee in each regional EPA office.

Council on Indoor Air Quality

The bill also authorizes the already functioning Council on Indoor Air Quality (CIAQ). The CIAQ is a federal government interagency coordinating body representing the departments of Health and Human Services, Housing and Urban Development, Energy, Transportation, the Consumer Products Safety Commission, and the General Services Administration. The council will make a biennial report to Congress. Funding for the CIAQ will come from $10 mil-

lion per year which must also pay for the national response plan, the federal response plan, and the information clearinghouse.

IAQ Information Clearinghouse

The bill establishes an information clearinghouse and authorizes $2 million per year for its operations.

Possible Change in Bill

Inside sources have told us that Sen. Mitchell contemplates changing the Senate bill to require EPA to monitor private-sector activities. This would certainly improve EPA's perspective on IAQ problems. It may help correct the tendency of federal bureaucrats to see government as the locus of action and mistakenly to view builders as a homogeneous, monolithic group.

The construction industry does represent a major segment of the nation's economy. However, it is diverse, dispersed, and consists of a very large number of small and medium-sized operations. For example, in spite of the presence of a few very large residential developers, most homes are constructed by builders who construct fewer than ten homes per year. As many as ten percent of single-family residences are owner-built.

Understanding and regulating building products is a tremendous challenge. Literally hundreds of different products go into each building, and there are many choices for each product. Many manufacturers produce any given type of product (one exception is in the fiberglass insulation industry, where only three firms dominate the market). Construction practices vary considerably in different regions of the country as well.

Unfortunately, EPA's funding is miniscule compared to the amount of money that goes back and forth in the building industry. Design fees alone for a single large building project can approach the amount authorized for research and health advisories in the Mitchell bill. EPA will need an enormous increase in funding to really get a handle on all the issues identified in the bill.

Hearings Schedule

Sen. Frank Lautenberg (D-NJ), chair of the Subcommittee on Superfund, Oceans, and Water Protection, has tentatively scheduled a hearing on the Senate bill for May 3rd. Hearings in the House are expected to begin this summer.

Congressman Kennedy Sums It Up

In the House, when Rep. Kennedy introduced the same bill as H.R. 1530, he made the following remarks: "Mr. Speaker, take a deep breath. The air that is now in your lungs passed through several hundred feet of dark, dusty, dirty ductwork before reaching this room. Twenty-seven species of fungus have been found growing in the dark recesses of building ventilation systems. Viruses and bacteria that thrive in air ducts have been proven to cause influenza, pneumonia, tuberculosis, and...deadly Legionnaire's disease. In addition to those living dangers, the air we breathe indoors can also contain high concentrations of radon, asbestos, formaldehyde, benzene, carbon monoxide, tobacco smoke, lead, chlorine, low-level ozone.

"Mr. Speaker, this is a problem that has remained hidden for too long in the dusty corners and dark bowels of the buildings around the country. I took off the grates in my own office in the Longworth Office Building and found mildew, mold, and spores nearly two inches thick in the heating duct. If every one of our colleagues did the same, I don't think we would have any problem in passing this bill tomorrow." ♦

SEIU Sues EPA on Asbestos

As we go to press we have learned that EPA has rejected SEIU's petition to extend asbestos rules to cover nonschool public access buildings. SEIU has filed a lawsuit, and sources inside SEIU told us that they expect to win. If they prevail, assessment of asbestos hazards in commercial buildings will be required and workers would be notified if they are exposed to such hazards.

We expect to cover this issue in greater detail next month. ♦

Feature

Specifying Interior Materials

Some building materials and furnishings are important sources of toxic or irritating chemicals that may cause building occupants to complain. Last month, we described a process for evaluating building materials and furnishings. This month, we continue our discussion of materials and provide practical suggestions for writing specifications. The suggestions provided here do not substitute for the advice of competent experts, but they are a starting point for taking positive action in your next design or building project.

General Considerations

Certain materials are more important sources of volatile organic chemicals (VOC) than others. These include carpets, adhesives, caulks, sealants, paints, insulation, and office workstation furnishings. We address each of these products below. Suggestions for one material may be applicable for other materials, although they are not repeated in detail for each product.

Some products are more important than others because their emissions are larger or the VOC they emit are more toxic or irritating.

The quantity and type of use will affect the significance of any particular product. See last month's *IAQU* for a discussion on how to evaluate the importance of a particular product or material.

Researchers at EPA, NASA, and the Saskatchewan Research Council have all found that emissions from interchangeable building products can vary by factors of 100 or more. While insufficient emissions data are available at this time, a lot of product emissions testing is occurring in the building products and furnishings industries. Their testing will likely lead to changes in many products and to the removal of particularly noxious products from the market.

Designers, builders, facilities owners, and building operators can request test data from product manufacturers. In some cases, the data are available and will be readily provided. Where it is not available, asking for it will motivate the manufacturer to obtain it.

Carpet

Carpet installations are frequently implicated in indoor air pollution incidents. Not enough information is currently available on carpet emissions to permit selecting or detailed screening of products on the basis of carpet composition or emissions.

Manufacturers of commercial carpet products are keenly aware of indoor air quality issues, and several have initiated testing programs. Data from these tests can be helpful in evaluating candidate products. Manufacturers may use the data to modify their products or to use in the event of a lawsuit involving their products. Their activities may also result in marketing themes based on claims of low emissions.

Of course, different test procedures will produce different results. If you receive emissions data from a manufacturer, be sure to request a copy of the test method. The history of the sample prior to testing can also significantly affect test results. Important factors include exposure to air movement, temperature, and conditioning prior to testing.

Levels of emissions decline rather rapidly, on the order of 10 to 50 times within the first three to six weeks of exposure to the environment after installation. The VOC air levels from materials in newly constructed or furnished buildings will decline rapidly. Maintenance products, consumer products, and other sources of VOC will become the dominant sources as time passes. Careful selection of building materials and furnishings alone will not eliminate VOC problems from buildings. But limiting materials' emissions is within the control of the designers and builders, and reducing problems in newly completed projects can significantly affect occupants during the early occupancy period.

The size of the project (and therefore, the potential purchase) will affect the amount of cooperation you can expect from manufacturers. Large firms and building owners have clout. Smaller offices or builders may have to wait until the some of the ice is broken by bigger firms. But it is worth asking for the information; if even one of the manufacturers is willing to provide it, that information can be the basis for putting pressure on others.

Specifications

Include the following in your specifications:

1. Carpets shall be designed, manufactured, handled, installed, and maintained in a manner that will produce the least harmful effects on occupants of the building.
2. The manufacturer of the carpet shall avoid unnecessary use of chemicals that are toxic or irritating in the manufacture, treatment, or handling of the carpet products.
3. The manufacturer shall implement measures to reduce installed carpet emissions of chemicals which are toxic or irritating.
4. Manufacturers of carpets shall submit the following:

- A list of all chemicals used in the manufacture of the carpet. This list shall include a breakdown of the contents by weight or volume.
- A description of any procedures used by the manufacturer to minimize the emissions of VOC from its product(s).

- A description of all testing performed by the manufacturer, its agents, contractors, or any other party that provides information on the chemical composition of the finished product; the emission rates of VOC from the finished product; and a list of all chemicals found in emissions testing, headspace testing, or other tests providing evidence of the emission products, quantities, and decay rates. For all such tests, a description of the test methods used, the history and conditioning of the samples tested prior to the test process, the raw data obtained from such tests, the agency performing the tests, and the reported results of the testing process.

Review Submittals

Review the submittals responding to the specifications and compare the results from candidate products. On the basis of the submitted data, including but not limited to the test results, determine the need for additional testing or other evaluations. Refer to *IAQU*, March 1989, for information about testing.

Conditioning Carpets

Based on the data obtained from manufacturers and testing, if done, determine the need for carpet product conditioning prior to installation in the building. Conditioning can occur at the factory prior to shipment, at the site prior to installation, or *in situ*.

Remember, VOC emissions are a function of material temperature, air movement above the carpet, concentration of VOC in the air above the carpet, and the concentration and distribution of VOC in the carpet. Elevating temperature, maintaining good air movement above the carpet, and providing good ventilation accelerate emissions.

Since most floors are relatively massive, it takes far longer to raise their temperatures measurably than it takes to increase air temperature. Trying to condition carpets in place will take several days, and perhaps as long as a week, to achieve any real effect.

It is far better to condition carpets just after the manufacturing process. A conditioning step after manufacturing would be running the carpet through a well-ventilated, heated chamber. The carpet manufacturing process involves several steps in which the product is heated to very high temperatures but in closed chambers. Thus, emissions do not escape, although they may move from the interior to the surface of the product. Chemical changes also occur during the heat cycles.

VOC may be loaded on the surface of carpet fibers as a result of the manufacturing process. When carpets are first exposed to the air in a building, there is a burst of VOC release; this explains the noticeable odor. Allow this burst to occur outside the building. This will considerably reduce the amount of offgassing that will occur indoors.

Whether it is done at the factory, in a warehouse, or outdoors, it is worth considerable extra effort to provide for outgassing before bringing the carpet product into the building.

Carpet Adhesive

Carpet adhesives are also sources of indoor air pollutants. Adhesive specifications are typically prepared by the carpet manufacturer. Many IAQ concerns may be addressed by minimizing the quantity of adhesive used and the toxic or irritating chemical constituents of the adhesive. Use the maximum feasible ventilation during the carpet installation.

EPA's Public Access Buildings Study found VOC emissions nine times greater from carpet adhesive than from the carpet it was used for. Adhesive emissions may occur faster, however, and long-term comparisons were not conducted in that study.

Include the following in the specifications:

- Clearly state the client's concerns about indoor air quality and potential chemical emissions from the adhesive product. Include concerns about odor, irritation, and toxicity of adhesive emissions.
- Require that the adhesive specification by the carpet manufacturer provide for the smallest quantity of adhesive consistent with the requirements of product application.
- Require that the adhesive have the lowest content by volume of toxic or irritating chemicals while meeting with the requirements for product application.
- Require the manufacturer of the candidate adhesive product to submit a list of all chemicals contained in the product and their composition by volume or weight.
- Require the manufacturer of carpet adhesive to submit results from any testing of the product that indicates its performance in relation to indoor air quality. Specifically, request results from tests of drying times, emis-

sion tests of VOC, or any other tests performed by the manufacturer that will allow evaluating the impact of the carpet adhesive on indoor air quality.

Evaluate the Data

Evaluate the submittals and determine the need for further evaluation, testing, or modifications to the products. If you obtain data from several products, compare the results. Do not hesitate to ask questions. Get answers to important questions in writing. If you are unable to interpret the data, consult with an industrial or analytical chemist, industrial hygienist, or other qualified professional.

Provide Required Ventilation

Determine the need for temporary special ventilation during and immediately following carpet installation to reduce the airborne concentrations of carpet adhesive vapors. In general, such ventilation is almost always a good idea. The longer you ventilate after installation, the lower the residues when the space is occupied.

Provide for such ventilation as required. The specifications should require that the HVAC system be operational prior to the installation of the carpet. The preferred HVAC system operation uses supply air fans and ducts only; exhaust is provided through windows (if operable). This reduces contamination of return air ducts, plenums, and insulation materials. If operable windows are not present, create temporary openings by removing glazing panels. In some special cases, use exhaust fans to pull exhaust air from deep interior locations. Stair towers and other paths to the exterior are useful for exhausting air from the building during temporary ventilation. This temporary ventilation approach is also useful during painting, installation of furnishings, and other such operations.

Vinyl Composition Tile and Other Flooring Products

Considerations for these products are similar to those for carpet and carpet adhesive. Minimizing the quantity of adhesive used, the toxic or irritating chemical components of the adhesives, and the emissions from the product are the goals. Specifications should advise contractors and manufacturers about indoor air quality concerns and require submission of the relevant data. Temporary ventilation will be useful in reducing air levels and residues of emissions.

Adhesives Used for Miscellaneous Applications

All adhesives, whether solvent or water based, result in emissions of VOC to indoor air. Many of the VOC emitted from common construction and furnishing adhesives are known irritants and toxins. To avoid occupant discomfort, irritation, and health effects, employ all practical measures to minimize exposure of building occupants to these VOC.

Airborne residues of adhesive VOC emissions measured in laboratories and in the field demonstrate an extremely wide range of emission products, rates, and decay rates. Therefore, evaluate adhesive products to be used in the project.

Specify requirements for all adhesives similar to those for carpet adhesives as discussed above. Also include a general specification specifically for the adhesives. It should be inserted at the beginning of each division in the specifications where adhesive materials appear. It should include the statements of your concern regarding indoor air quality, the requests for information, and the requirements for ventilation during and after adhesive applications. Use the selection procedures and ventilation measures described above.

Caulks, Sealants, Glazing Compounds, Joint Fillers

These "wet" building products may emit VOC after installation in the building. Considerations similar to those for adhesives apply, and the range of measured emissions is very great indeed. Therefore, selecting products with low emissions and low content of toxic or irritating components can significantly reduce occupant exposure to indoor air pollutants.

Tests of a variety of sealant products performed by researchers at the Saskatchewan Research Council have found large variations in weight loss, rate of weight loss, and calculated complete drying times. A styrene ethylene butylene styrene sealant lost 37% of its original weight during the first 48 hours and was projected to lose 61.7% upon complete drying at 79.3 hours. The emissions were petroleum hydrocarbons and xylene.

A styrene butadiene rubber compound was calculated to lose 35% of the original sample weight when fully dried at 253 hours. 16.4% of the original weight was lost in the first 48 hours. The emissions were aliphatic hydrocarbons and xylene.

Meanwhile, a one-part chlorosulfonated polyethylene product lost only 4.4% of the original sample

weight in the first 48 hours and a calculated 14.4% when fully dried. The emissions were primarily xylene and the complete drying time was estimated at 447 hours.

A one-part polyurethane lost nearly the same amount when fully dried but lost only 1.2% of the original sample weight after 48 hours. Its emissions were also primarily xylene. Its complete drying time was estimated at 8,269 hours, nearly a year.

Silicone caulk lost 2% of its original weight after 48 hours and a calculated 2.5% in the next 487 hours to dry. The VOC emissions were xylene, considered moderately toxic by Sax (see references). Table 1 is a summary listing of the Saskatchewan research.

From Table 1, we can see that product characteristics vary considerably. A compound may have very high emissions but dry rather quickly. Another may have low total emissions and dry slowly. Every other combination is also found. These facts make it clear that it is important to obtain actual performance data on the products, that it does make a difference which products you choose, and that there is no correlation between total emissions and complete drying time.

Slow-drying products are the worst from an indoor air quality perspective unless their emissions are negligible. Fast-drying products like the styrenes emit significant fractions (1/3 - 3/5) of their total weight, but they do so in a matter of three to ten days, mostly in the first two or three days. Thus, if you apply these products while using adequate ventilation, they are reasonably acceptable for indoor air.

The size of the bead is also variable. The tests were done with beads 6 m x 6 mm x 304.8 mm (19.68 ft x .24 in x 1 ft). Bead size affects the emission rate. Emission processes are a function of evaporation from the surface and diffusion through the material to the surface. Of course, a flat section will have more surface area and less interior volume than a round section. Drying or evaporation will be quickest from the surface and slowest from the center. The further vapors must travel to reach the surface, the slower the drying time.

The physical structure of the material will also affect the outgas rate, although this cannot be predicted precisely without consid-

Table 1. Emissions data for various sealing products from Jennings, et. al. (see references at end of article).

Product description	Weight loss in % of original sample @48 hrs	Weight loss in % of original sample @fully dry	Calculated complete drying time (hrs)	VOC emitted	THR[a]
Styrene butadiene rubber compound	16.40	35.26	253.7	Aliphatic hydrocarbons	MOD
				Xylene	MOD
Oleoresinous	0.68	4.42	1962.4	Aliphatic hydrocarbons	NA
Polysulphide one-part	0.56	6.20	4931.9	Toluene	MOD
Butyl rubber	5.26	17.69	434.3	Aliphatic hydrocarbons	NA
Acrylic emulsion latex	5.48	11.80		None detected	
Acrylic solvent-based	3.26	13.51	1052.2	Xylene	MOD
Polyvinyl acetate-based emulsion	16.85	26.61		Negligible Quantities	
Vinyl-acrylic emulsion latex	12.70	30.05	317.3	Petroleum hydrocarbons	NA
Asphaltic one-part	1.37	8.09	4496.3	Petroleum hydrocarbons	NA
Neoprene one-part	18.00	32.75	214.0	Xylene	MOD
One-part chloro-sulfonated polyethylene	4.40	14.38	446.7	Xylene	MOD
Polyurethane one-part	1.20	14.86	8269.4	Xylene	MOD
Silicone	2.06	4.49	487.2	Xylene	MOD
Polybutene	2.39	9.19	627.8	Petroleum hydrocarbons	NA
Styrene butadiene rubber	14.00	19.25	106.3	Xylene	MOD
Neoprene blend	17.40	23.21	101.4	Methyl ethyl ketone	MOD
				Xylene	MOD
				Toluene	MOD
Styrene butadiene	21.10	25.03	55.5	Hexane	LOW
				Toluene	MOD
Styrene ethylene butylene styrene	37.07	61.70	79.3	Petroleum hydrocarbons	NA
				Xylene	MOD
Nitrile	31.50	59.60	271.5	Methyl ethyl ketone	MOD

[a] THR = Summary toxicity statement from Irving Sax, *Dangerous Properties of Industrial Materials, Fifth Edition.* New York: Van Nostrand Reinhold, 1979.

erable research. Some materials quickly form a skin on the surface. This skin inhibits outgassing after it is formed. However, experimental testing of various products by the Saskatchewan researchers showed that after a few hours, the emissions tend to become more consistent among products regardless of some irregularities during the first few hours.

For specifications, follow the same procedures described above for adhesives. Specifications should require using the minimum quantities of these materials necessary to perform the required function, adequate ventilation during and after installation, and data from the manufacturers on contents and emissions.

Paints

Paint products contain a variety of VOC incorporated as drying agents, flattening agents, mildewcides, fungicides, and others. These VOC have been measured in indoor air many months after application of the paints. There is a wide range of formulations with an equally wide range of emission rates and chemical contents. Data from the EPA Public Access Buildings Study (*IAQU*, December 1988) showed a hundredfold difference in the VOC emissions from one latex paint and another.

Natural Paint Products

Some paint products are being marketed as "natural" or "environmentally safe." Two of these are imported from Germany; a third is made in the United States. We described two of these products (Auro Organic Paints and LIVOS PlantChemistry) in a previous issue of *IAQU* (May 1988).

Discuss your concerns with the manufacturers' representatives, and ask them to recommend products which will create minimal indoor air contamination.

Specifications

Based on the products identified above, develop specifications with the following requirements:

1. Evaluate paint products according to procedures described above for adhesives and other "wet" products.
2. Use maximum feasible all-outside-air ventilation during the application of paints to accelerate emissions and remove residues from the building.

Try Baking Soda

Some people recommend adding baking soda to paints before application to control emissions. We have tried this on a residential application using one pound of baking soda for each gallon of paint. It significantly reduced the apparent odor and drying time for the water-based latex interior paint we used. If readers have experience with baking soda or other methods that have worked for them, please write our editorial office.

Insulation

Insulation materials emit indoor air contaminants from their original composition. They also re-emit chemicals which are adsorbed on their very large surface areas. Insulation used for acoustic control is often "fleecy" in order to enhance its sound absorption capabilities. The fleeciness enhances adsorption of VOC and retention of VOC within the building.

Acoustic insulation materials, especially those used in HVAC duct work, are particularly challenging from an indoor air quality perspective. Fleecy duct linings inevitably become contaminated by particles and by biological aerosols which lead to microbial amplification. Covering them with impermeable membranes reduces their effectiveness for noise-control purposes.

It is most important to limit acoustical insulation application to essential uses. Where acceptable, apply it to the exterior of ductwork. Use sound baffles rather than insulation where they will do the job.

Thermal and fireproofing insulation materials do not necessarily need fleecy surfaces in order to work. However, the economical manufacture or application of the materials often results in a fleecy surface. Where possible, they should be coated with a smooth and impermeable membrane to reduce the adsorption of VOC on their surfaces.

To reduce the potential for microbial growth, control humidity within the ducts. Prevent condensation by properly locating humidification or de-humidification equipment.

Be sure that ductwork can be inspected and cleaned.

Workstation Panels

Because of the very large surface area of workstation panels, they are an extremely important factor in indoor air quality. Their VOC contents can be emitted to indoor air. Their fabric covering can serve as an adsorption surface for VOC emitted from other products or occupant activities and then act

as a "secondary source" of emissions.

One type of interior partition (workstation panel) contains chipboard material used for septums. While only 1/16 inch thick, it is made from recycled paper materials similar to the composition of food boxes or the chipboard found in tablets of writing paper.

If inspectors find the panel fabric is soiled, it is cleaned in the plant before being bagged in polyethylene film for shipment. About 25% of panels must have some cleaning. Cleaning is with 1,1,1-trichloroethane (methyl chloroform), a common cleaning solvent. It is a relatively volatile compound, which means that most of it will evaporate rather quickly when exposed to air in a well-ventilated space. It also means that a substantial portion of the residue on the fabric at time of packaging will be released in the building when the packaging is removed.

1,1,1-trichloroethane is one of many known eye and mucous membrane irritants commonly found in indoor air. It is also used as a pesticide and in textile processing. Because of its irritant potential, its concentration in indoor air should be minimized through all reasonable measures.

We have discussed with engineering staffs, the possibilities of allowing 1,1,1-trichloroethane-cleaned panels to be aired out before being packaged for shipping, and they have agreed that it is possible and reasonable. The furnishings industry is becoming much more aware of indoor air quality concerns, and some manufacturers are quite willing to discuss measures to minimize problems.

One large manufacturer of office furnishings is currently negotiating a contract with a testing laboratory where emissions from its products will be identified and quantified. This will motivate other large manufacturers to undertake a similar program.

A panel from a large manufacturer was recently tested and determined to have very high emissions of a solvent believed to be fairly toxic or irritating to humans. It is a chemical cousin of cellosolve solvents, some pretty nasty chemicals. A NIOSH current intelligence bulletin warned of their hazards. We could not find definitive toxicity information on this particular product, but its odor alone was sufficient to cause concern.

The molded fiberglass or other acoustic absorbant or barrier material behind the fabric can be a considerable source of VOC as well as a matrix and food source for microorganisms. Investigate the contents, emissions, and alternatives before you contract for office furnishings.

Recommendation

1. Communicate with workstation manufacturers' technical representatives to obtain the most comprehensive test reports available. If no testing has been done, consider using other products.
2. Evaluate results of testing and adopt mitigation measures based on those results. Consider possible changes in materials, airing out at the factory prior to packaging, airing out outside the building prior to installation, or conditioning *in situ*.
3. Consider the need for independent testing. More laboratories are becoming available to do this type of work. We will identify some of these labs in a future issue of *IAQU*.
4. Consider random testing of panels arriving on site to monitor emissions.
5. Include specification statements regarding concerns, identification of components, requirements for controlling emissions to minimum levels, and the need to address concerns prior to initiating manufacturing of the panels.

For More Information

Jennings, D., Eyre, D. and Small, M. "The safety categorization of sealants according to their volatile emissions." Ottawa: Ministry of Energy, Mines and Resources, Government of Canada. 1988.

Irving Sax, ***Dangerous Properties of Industrial Materials***, Fifth Edition. New York: Van Nostrand Reinhold, 1979. ♦

Products and Services

Enkavent Correction

Last month we wrote about a radon control product, Enkavent (*IAQU*, March 1989). We incorrectly reported the cost of Enkavent, which is manufactured by Akzo Industrial Systems Company, as $9 per roll. Akzo's advertising agency, Price/McNab in Asheville, North Carolina, has written to advise us that the cost is $9 per square yard, or a dollar per square foot. We thank them for that correction.

We also called the retailer in northern California from whom we received the original pricing information. They told us their price is $1.25 per square foot, or $187.50

per roll, for quantities up to 19 rolls. For 20 to 99 rolls, the price is $172.50 per roll.

We regret any inconvenience we have caused our readers or Akzo Industrial Systems Company. Even at the significantly higher cost, we think the product looks good. We would like to get some feedback from readers who have experience using Enkavent. For more information: Akzo Industrial Systems Company, P.O. Box 7249, One North Pack Square, Asheville, NC 28802; (704)258-5050.

Practical Research Briefs

Multiple Chemical Sensitivities

A controversial topic can generate constructive debate, useless bickering, or anything in between. The subject of multiple chemical sensitivities (MCS), also known as chemical hypersensitivity, environmental illness, and total allergy syndrome, certainly generates controversy. Debate rages over the nature of the illness and its causes, whether treatment should be covered by public and private health insurance programs, and how employers and building owners should work with chemically sensitive individuals.

An article in the current issue of the quarterly, ***The Amicus Journal***, published by the Natural Resources Defense Council (NRDC), explores the illness from the point of view of a chemically sensitive psychologist's perspective. Linda Lee Davidoff, president of the Chemical Sensitivity Disorders Association in Baldwin, Maryland, writes: "MCS remains puzzling and elusive in part because it does not mark the sufferer with an identifiable cluster of symptoms. The range of symptoms varies from mild to life-threatening."

Interestingly, many of the symptoms are identical to sick building syndrome complaints, and this could be a confounding factor in SBS studies. The National Research Council Board on Environmental Studies and Toxicology estimates that 15% of the population experiences hypersensitivity to chemicals found in common household products.

Sensitization to chemicals is accepted by scientists as a bonafide phenomenon. Formaldehyde, isocyanates, pesticides, solvents, and many other common indoor air pollutants are recognized sensitizers. Once a person is exposed to a sensitizing dose or sequence of doses, a far lower dose can bring on symptoms. Chronic exposure to low doses can also create the condition, according to Davidoff.

NRDC Staff Attorney Jacqueline Warren is quoted in the article. She says: "The contamination of the indoor air with toxins and the subsequent risks of chronic disease and permanent sensitization is one of the most serious unaddressed and underestimated of public-health problems today."

The debate about chemical sensitivity and its possible psychological causes parallels the debate about SBS and mass hysteria or mass psychogenic illness. Answers to questions about the causes and mechanisms of either MCS or SBS are likely to increase our understanding of the other. We look forward to such illumination.

Reference: ***The Amicus Journal***, Winter 1989, Vol. 11, No. 1. ♦

Information Exchange

The Radon Industry Directory Now Available

The cover says: "Everything you need to know, everyone you want to reach," and the 533 pages of ***The Radon Industry Directory*** appear to live up to the promise. The directory is comprehensive, well-organized, easy to use, and easy to read. It will be a valuable reference or marketing tool for radon industries. It also contains a substantial amount of information useful to a much broader IAQ audience.

The contents include listings of radon detection and radon mitigation companies, alphabetically and by state; radon product manufacturers in several categories; research facilities; training/workshop/course listings; radon associations; state and federal government listings; legislation; public interest groups; real estate groups; radon publications; a glossary; and several other topics. It also features an index of names, organizations, and advertisers.

This exhaustive directory is useful for an industry which has grown so quickly and haphazardly. More basic technical information should be included as well as a more comprehensive — and, perhaps, annotated — bibliography. The list of publications is scant, and the reader is left without much guidance on contents, value, or availability. The technical listings assume that the reader knows how to evaluate or can find out what they need. But the "Radon Overview" section is less than two pages, extracted from ASHRAE's Indoor Air Quality Position Paper.

The directory is published by the Radon Press Inc. and available from *IAQU* publisher Cutter Information Corp., 1100 Massachusetts Ave., Arlington, MA 02174, (617)648-8700. The cost is $75/copy. ♦

Radon Control in New Home Construction Video

The Extension Energy Program at Oregon State University released a new video on radon this month. The video, titled "Radon Control in New Home Construction," describes factors affecting radon concentrations in homes and the principles of radon control. The video is 20 minutes long and illustrates control methods for crawl spaces, slabs-on-grade, and basements.

The OSU Extension Energy Program has also produced other IAQ-related videos including one on air-to-air heat exchangers and another on controlling moisture in homes. The radon program is available for $20 for VHS format, $40 for 3/4" format. Request a free copy of their catalog and order videos by calling (503)754-3004. ♦

From Our Readers

Amines and Humidification Equipment

Humidification of large buildings presents many potential problems, not the least of which is contamination of building air from the chemicals used in the humidifier water. The secret to proper steam humidification is using the right materials for corrosion protection while avoiding chemical overfeed, which can result in contamination of building air.

Chemicals have been used for decades to protect piping and other equipment from corrosion and the subsequent need for replacement. Most waters are alkaline, containing carbonates and bicarbonates. As these compounds break down in a boiler, they produce CO_2, which is volatilized with the steam and redissolved in the condensate. The dissolved CO_2 forms carbonic acid, which attacks condensate lines and causes piping failures that are sometimes catastrophic.

The chemicals used for corrosion protection include two types of amines, neutralizing amines and filming amines. The FDA has established allowable maximum levels for the use of certain amines in steam that contacts foods other than milk products. The FDA permits neutralizing amines including diethylaminoethanol (DEAE), cyclohexylamine, and morpholine that contact nondairy foods at levels of 10 to 15 ppm. Recent studies have shown that when DEAE is released in occupied spaces, it forms a film that causes eye and skin irritation, headaches, dizziness, and other adverse health effects. NIOSH has recommended eliminating exposure to DEAE.

Filming amines form a non-molecular coating that protects the inside of piping from attack by carbonic acid or oxygen. Octadecylamine is considered acceptable at levels up to 3 ppm for use in contact with non-milk-product foods. Concentrations up to 2.4 ppm are permitted where steam is used for sterilizing surgical instruments.

Some cases of sick building syndrome probably result from exposure to such amines, according to the author and others. Yet, failure to use some form of chemical treatment may result in rapid deterioration of HVAC equipment.

Michael Munk (see below) recommends steam line protection without chemical treatment, although he did not provide details. Contaminated steam can result in significant legal liabilities, for example, in health care facilities where patients already have compromised respiratory or cardiac function.

Many buildings are not humidified, but this results in discomfort and some SBS complaints from very dry air, especially during the heating season. Building types which require humidification include the following:

1. Certain hospitals under regulation of federal or state laws or other hospital facilities standards;
2. Printing and publishing plants, libraries, and museums;
3. Textile manufacturing plants;
4. Electronic data processing centers including mainframe facilities, financial trading floors, and desktop EDP operations;
5. "Quality" corporate headquarters, especially those including natural furnishings, natural finishes, or artwork;
6. Recording and photographic studios; and
7. Laboratory animal facilities.

[The following is an edited version of a letter and a technical note that came in response to the portable room humidifiers article in the March issue of *IAQU*. Mr. Munk's letter deals primarily with legal considerations rather than technical ones. We believe the issues addressed are significant, although

cal ones. We believe the issues addressed are significant, although we have not assessed the merit of his ideas. We welcome comments from our readers. — Ed.]

Dear Mr. Levin,

I believe your readership may appreciate [the technical note] as an article. This secondary amine problem is a sleeper only beginning to stir. Frequent IAQ epidemics have been traced to steam humidifiers.

Technical Note: Steam conditioning chemicals, steam humidifiers and OSHA HCS compliance regulations.

In response to many requests for information regarding OSHA regulations and their relationship to steam humidification equipment, I provide the following advisory. I hope that it helps as part of long- and short-term risk management planning program for environmental chemical exposure problems and helps define the problems for management, where it belongs. Environmental compliance to new law, *OSHA; 29 CRF Part 1910, et al; Feb. 15, 1989; Hazard Communication*, is more than engineering, insurance, or an industrial hygiene problem.

The recommendations that follow are general enough to be carried out with any responsible consulting or service company with humidifier/humidification expertise that includes the environmental impact analysis. As a caution, consultants, licensed professionals, are legally bound to exercise their sworn "duty-to-warn." EPA and NIOSH pressure has been brought to bear on A/E firms to make disclosures of potential hazards in buildings. Service companies are not encumbered with hazard disclosure requirements.

Hazardous potential findings like asbestos, structural faultings, PCBs, radon citings, and the secondary amines are finding distinct routings from consultants through professional risk managers and their insurance company counterparts and the environmental policy directors. On this basis, we recommend that the short-term solution implementation starts with hiring a consultant for preparing the engineering portion of an environmental impact statement. Your own people should advise as to whether this might best be done through an outside law firm and bound by client confidentiality.

Short-term compliance procedure:

Retain a legal firm to advise in regard to OSHA, HCS environmental requirements regarding HVAC humidifiers to which any MSDS described chemicals have been added.

Give them this assigned scope of work (minimum):

Include, by assignment of a contract that your company has executed with a consulting engineer (an in-house P.E. can perform these services, or even an in-house legal department under a confidential disclosure directive) for making an environmental impact study of any humidifiers which are currently in use and are chemically dependent.

Chemical dependence is defined as equipment which requires dosing or treating the humidifiers' waters through manual and automated addition of chemicals that have MSDS listings citing potential exposure hazards.

Include having the attorneys obtain, in writing, from your company's present suppliers of chemicals and chemical services for chemically dependent humidification equipment, an environmental impact statement. That company's assessment must be specific to HCS compliance requirements for their chemicals passed through your humidifiers into employee workplaces. It should also include a "probable employee exposure annual dose" based upon annual purchase records of these chemicals.

[Ed. note: Munk wrote that he received a suitable response from Union Carbide, but that "not all suppliers are as sensitive as UC with respect to environmental happenings."]

Have the legal firm summarize both the engineer's and chemical supplier's reports. That might include an engineers duty-to-warn statement all correlated specifically to *OSHA; 29 CFR Part 1910, et al; Feb 15, 1989; Hazard Communication.*[1]

Have the attorney, in writing to the regional OSHA, ask for specific guidance with respect to what the OSHA, HCS requirements are for the specific chemicals and annual exposure levels to which employees might be exposed by the use of humidifiers to condition workplace ventilation air, in accordance with *OSHA; 29 CFR Part 1910, et al; Feb 15, 1989; Hazard Communication.* These regulations are in a continuous state of revision and responses are very slow at present and responses begat responses. It can take a long time to get specific answers to specific questions.

Include having the attorney instruct you as to the specific disclosure to be made from the OSHA responses to his questions.

Discuss the attorney's recommended HCS disclosures with your company insurance executives. A final determination of the exact nature of the final HCS reporting to any of the chemically exposed employees should reflect the position of your company's insurers.

Make the appropriate HCS disclosure to the employee.

Make a long-term plan aimed at upgrading or abandoning chemically dependent humidifiers for chemical independence.

Have your attorneys write the nature of your long-term plan to the regional OSHA agency requesting approval of the plan and a request for notice, subject to the calendar of environmental law enforcement in this specific area so that your company may fund the projects.

While the above procedure is easy for a large corporate infrastructure that contains legal, risk management, industrial hygiene, insurance and engineering departments, it seems mind boggling for small business.

For small business, or middle-management caught in the divisional wars of major corporations, the same program can be carried out through using a service company for an initial assessment and recommendation. The service company's proposals are specifically stated responses to your RFP and define the recommendations to bring your equipment into compliance with prevailing environmental law. Take a few proposals. I would suggest at a minimum at least your own water service chemical contractor and one of his competitors.

Also, retain an HVAC service contractor who takes operating responsibilities for building equipment on annual contracts. Pick one of the national building service management companies. Take proposals from a specialty firm, such as our own or Honeywell's Indoor Air Quality Diagnostics unit, that will generate proposals geared to their assessment of your RFQ's needs. If your RFP is specific to chemically dependent humidifier problems you can get very specific responses.

You can send a summary of the proposal responses through to your management. If the consensus is strongly in favor of doing something to achieve compliance, recommend that management take up the matter with whomever handles the firms legal and insurance affairs. In doing this you transfer responsibility and accountability from your desk to management's.

Environmental law is new business. The intent of this article is to point to some, if not all of the steps and disciplines to move the problem away from yourselves into appropriate executive decision paths.

Very truly yours,
Michael Munk
CFSI Environmental Services,
Rye Brook, NY

Electrostatic Fields to Control ETS

Hal,

I was given a few pages of the February issue of ***Indoor Air Quality Update*** in which you mention my research. The article is fine except that the reader is left hanging by questions raised but not answered. I think your readers would be more satisfied if they had the answers and it would avoid misunderstandings about a useful developing technology. Thus, I've written the enclosed note answering the questions. I would appreciate it if you consider publishing the note.

An article in the February issue described a technology in which electrical fields in ducts were found to alleviate the discomfort caused by tobacco smoke in a room. This technology, it was pointed out, provides an alternative to the use of very high air exchange rates. The article closed by raising several questions. This note is the answer to those questions.

A question was raised as to whether there are any potentially harmful effects. Since there are only a few milliamperes of current used, there is not sufficient energy to break bonds. Thus, the answer to the question is no.

There was a question as to what ultimately happens to the tobacco smoke. The results of published research clearly indicate what happens. Briefly, the in-duct electrical fields accelerate the natural process of coagulation. Thus the fine particles in the room, 97% of the particles, do not plate-out and contaminate people and surfaces as they typically do. Instead, they coagulate into larger particles that can be entrained by air currents and carried back to the filter and removed. Thus, the filter gets dirty and the people and surfaces stay clean (1, 2).

A question was raised as to whether toxic chemicals condense on the particles and might stay in

A question was raised whether this technology can be effectively commercialized and achieve widespread use. One variant of this technology has already proven commercially successful in numerous installations such as the Disneyland Hotel Convention Center, Dallas-Fort Worth Airport, Northern Telecom Computer Center, etc.

1. The influence of electrostatics on aerosol deposition. ***ASHRAE Transactions***, 92, 1986, 55-64.

2. Modification of aerosol size distribution by complex electric fields. ***Bulletin of Environmental Contamination and Toxicology***, 34, 1985, 850-857.

3. Using in-duct electrical fields to reduce particulate and gaseous contamination. ***Microcontamination***, June 1988, 27-32.

4. Reduction of formaldehyde, ammonia, SO_2 and CO_2 concentrations in air. ***Journal of Environmental Science***, July/August 1986, 57-59.

Regards,
Allen H. Frey, Ph.D.
1334 Orcap Way
Southampton, PA.

Editor's Reply:

We are pleased to receive your note and provide our readers with your answers to the questions we raised. Our readers will certainly be more satisfied if they have answers. We try to provide the answers we have, and where we lack them, to provide the question in the hope that some reader will write in with the answers. Your letter demonstrates that the process works.

One comment is warranted on the system of air cleaning as described in your response. We believe that many of the harmful substances in ETS are volatile and semi-volatile compounds. As the filters load up, so will the fibrous glass duct liners used for thermal and acoustic insulations in HVAC systems.

Of course, the filters will need to be changed more frequently to prevent problems. However, the insulation materials are not replaceable the way filters are, and they may become sinks and then secondary sources for even higher loadings of organic chemicals. They may also be enhanced as amplifiers of microbiological organisms which will find them moister and even more nutritious with the enhanced deposition of VOC and semi-volatile organic chemicals.

The answer, of course, is to place a set of filters immediately after the electrical fields, to change the filters regularly, and to inspect the system regularly to identify increased soiling or contamination resulting from the increased particle deposition.

Editor: Hal Levin

Publisher: Karen Fine Coburn

Circulation Manager: Kim Gay

Reprint Manager: Ed Coburn

Production: Karen Kunkel Pasley

Editorial Office:

INDOOR AIR QUALITY UPDATE
2548 Empire Grade
Santa Cruz, CA 95060
Phone: (408)425-3846

Circulation Office:

CUTTER INFORMATION CORP.
1100 Massachusetts Avenue
Arlington, MA 02174, U.S.A.
Phone: (617)648-8700
Telex: 650 100 9891 MCI UW
Fax: (617)648-8707

Subscriptions:

$207 per year for single subscription (U.S. and Canada); $247 foreign subscription. Published monthly by CUTTER INFORMATION CORP.