KEEPING BUILDINGS HEALTHY

How to Monitor and Prevent Indoor Environmental Problems

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Philip Hagan
Ronald Gots
Alan Hedge

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## Contents

### Introduction xiii

#### About the Authors xviii

1. Does This Building Have an Indoor Environmental Quality Problem? 1
   **Philip Hogan**

   - Introduction 1
   - What Is an Indoor Environmental Quality Problem? 1
   - Definitions 2
   - Managing IEQ 4
   - Triggers for IEQ Investigations 10
   - Responses by the IEQ Team 12
   - Building Codes 16
   - Federal Guidelines 17
   - State Regulatory Programs 20
   - Indoor Environmental Standards and Guidelines 21
   - Mitigation and Control Strategies 23
   - Notes 26

2. What Factors Can Affect an Indoor Environmental Quality Complaint? 29
   **Philip Hogan**

   - Introduction 29
   - Water Quality 29
   - Noise 33
   - Lighting 34
   - External Factors that Affect IEQ: Indoor Environment/Climate/Weather 35
   - Internal Systems Factors: Pollutant Pathways and Driving Forces 38
   - Heating, Ventilation, and Air-Conditioning Systems 39
   - Housekeeping 47
   - Routine Operations 49
   - Site Characterization 50
   - Resolution of the Complaint 51

### Indoor Air Pollutants 51

#### Allergens and Pathogens 59

#### Controlling Biological Contaminants 61

#### Sampling for Industrial Hygiene 66

#### Notes 69

3. Investigating Health Complaints 71
   **Ronald E. Gots**

   - Introduction 71
   - The Many Causes of Symptoms: Differential Diagnosis 73
   - Effective Triage 75
   - Investigation 81
   - Evaluating and Choosing Consultants 85
   - Case Studies 87
   - Summary 90
   - References 90

4. Indoor Air and Health: Clear-Cut, Equivocal, and Unlikely 93
   **Ronald E. Gots**

   - Introduction 93
   - Indoor Air’s Scientific Debate 94
   - Terminology 96
   - Medical Investigation of Causation 98
   - Building-Associated Symptoms 99
   - Factors in the Workplace That Can Produce Symptoms 99
   - Chronic Illnesses Alleged to be Caused by Environmental Factors in Office Buildings 107
   - Summary 110
   - References 111

5. What Can We Learn about Indoor Environmental Quality Concerns from Studies? 119
   **Alan Hedge**

   - Overview 119
   - Factors Causing IEQ Concerns 119
   - IEQ Concerns and Nonenvironmental Variables 124
   - Factors Causing SBS: A Multifactorial Model 126
   - Summary 128
   - References 129

   **Alan Hedge**

   - Building Standards 137
   - Sick Buildings or Sick People? 138
   - Results from IEQ Research Studies 139

7. Personal Influences on Reporting IEQ 141

   - Cognitive Influences on Perceived SBS 146
   - Psychosocial Influences on Reporting SBS 149
   - Multiple Chemical Sensitivity and Environmental Illness 151
   - How to Tell Sick Building Syndrome from Mass Psychogenic Illness 152
   - Are Psychosocial Factors the Real Culprits? 154
   - References 156

8. Communicating Results of the Investigation 163
   **Alan Hedge**

   - Introduction 163
   - Organizing and Managing Information Flow 163
   - Responding to News Media 166
   - Newspaper and Magazine Interviews 168
   - Radio Interviews 170
   - Television Interviews 172
   - “Ambush” Television Interviews 173
   - Formal News Conferences 174
   - Preventing Panic 175

9. Government Inspections of the Building 177
   **James T. O’Reilly**

   - Practical Issues 177
   - Legal Rights 178
   - How the Inspection Is Conducted 179
   - Required Reports 179

10. Indoor Health Litigation and the Building Management 181
    **James T. O’Reilly**

    - Introduction to Litigation Options 181
    - Why Would Anyone Sue? 181
    - What Does the Indoor Health Claimant Need to Prove? 182
    - What Steps Should Be Taken when a Lawsuit Is Threatened? 183
    - What Steps Should Be Taken When the Suit Is Filed? 184
    - Who Are the Defendants? 185
    - When Is a Class Action Used? 185
    - Will My Deposition Be Required? 186
    - Do Lawsuits Usually Reach a Jury Verdict? 187

11. Litigation by the Tenant’s Employees 189
    **James T. O’Reilly**

    - Liability Risks for the Building Owner 189
    - Legal Theories 190
    - How Should the Building Owner Interact with Other Defendants? 194
    - Threats of Adverse Publicity 195
Chapter 3

Investigating Health Complaints

RONALD E. GOTS, M.D., PH.D.

PURPOSE

Though many books, chapters, and articles have been written about indoor air and health, they all lack a practical how-to quality. The purpose of this chapter is to provide a building manager with useful information to help assess the severity of complaints and devising an effective response strategy. To do so, those responsible for maintaining office spaces must understand some of the medical principles that underlie indoor air issues; these will be presented simply and practically. The ultimate purpose of this chapter is to keep those with financial responsibility for a building from doing too little or too much. Either can lead to dispassionate financial consequences.

INTRODUCTION

Indoor air issues begin with health or comfort complaints. Someone in the office (or perhaps many people) complains to the office manager, supervisor, or building manager. The complaints may involve pure comfort allegations—too hot, too cold, too dry—or they may involve more-specific complaints—headaches, burning eyes and nose, red eyes, cough, fatigue, nosebleeds. On rare occasions complaints may be even more dramatic—for example, mass faintings. Since these complaints are first fielded by a medical layperson, that person has the un-

The Many Causes of Symptoms: Differential Diagnosis

The essence of medical practice is the differential diagnosis. By this we mean that a constellation of symptoms leads to a number of considerations about possible causes. This in turn leads to a series of diagnostic tests to rule in or rule out any of the potential causes.

For example, if you complain to a physician about a headache, the physician will get a more detailed history from you and arrive at a preliminary differential diagnosis. That differential diagnosis may include a brain tumor, eyestrain, a cervical strain, a migraine, a sinus infection, stress, or many other conditions, any of which can cause headaches. Appropriate tests follow to rule out the most serious causes, such as a tumor. The process of evaluating workers with complaints is no different. Each symptom has many possible causes that can be ruled in or out only through a careful history, physical examination, and proper testing targeted to the differential diagnosis.

Unfortunately, indoor air complaints are only rarely evaluated in this fashion. Frequently, the first person involved is a heating, ventilating, and air-conditioning (HVAC) engineer, a maintenance person, or an environmental consultant. Thus, the decision that the problem is related to air is often made at the moment the complaint is initiated. That is a bit like sending everyone with a headache to a neurosurgeon to explore the brain for a tumor. Since many worker complaints have nothing to do with indoor air, many of these investigations assume, incorrectly, that poor air quality is responsible. Although building management must recognize this potential for error, cost and practicality demand that the simplest, most cost-effective approach be followed. This means that every symptom an office worker reports cannot support a full medical evaluation. Therefore, it is incumbent upon consultants and building engineers to know when to bring in medical help and when not to.

Symptoms in workers are often called health effects. This term is inappropriately used too early, because it makes the unsupported assumption that a symptom is the "effect" of something in the environment, when that remains to be proven. It also assumes that every complaint has something to do with health. Discomfort is not the same as ill health. A person may find a room too cold or too hot, hence uncomfortable. Or someone may have a minor symptom such as a transient headache or fatigue. Absent an underlying physical disorder, none of these situations can be said to imply an adverse health effect. Symptoms that could be treated are:

<table>
<thead>
<tr>
<th>Table 3-1</th>
<th>Causes of symptoms in building occupants: IAQ related, IAQ unrelated, and building unrelated.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAQ</td>
<td>Non-IAQ.</td>
</tr>
<tr>
<td>Building related</td>
<td></td>
</tr>
<tr>
<td>Sore nose</td>
<td>Thermal</td>
</tr>
<tr>
<td>Humidity</td>
<td>Lighting/Noise/Ergonomics</td>
</tr>
<tr>
<td>Odor</td>
<td>Psychosocial</td>
</tr>
<tr>
<td>Irritant</td>
<td>Political</td>
</tr>
<tr>
<td>Allergen</td>
<td></td>
</tr>
<tr>
<td>Pathogens</td>
<td></td>
</tr>
<tr>
<td>Medication</td>
<td></td>
</tr>
<tr>
<td>Building unrelated</td>
<td></td>
</tr>
<tr>
<td>Environmental and home allergens</td>
<td></td>
</tr>
<tr>
<td>Underlying disorders</td>
<td></td>
</tr>
<tr>
<td>Unrelated events (i.e., cancer and miscarriages)</td>
<td></td>
</tr>
</tbody>
</table>
workers may associate with the workplace are often quite varied in nature, hav-
ing little to do with one another or with a common cause. Figure 3.1 illustrates the chronic and diverse nature of symptoms or disorders that may be reported by office workers and that workers may relate to the workplace.

In the case of symptom complaints associated with office buildings, the differential diagnosis is complicated by a multidimensional consideration: the need to determine a diagnosis for the worker as well as for the building's condition and ultimately, to integrate the two. Not only are we trying to learn whether the headache is due to eyestrain or a brain tumor, we are also trying to determine whether environmental and/or psychosocial factors are contributing. Such a differential diagnosis is also complicated by multidisciplinary considerations. The person who diagnoses causes of headaches is not generally the one who decides whether the HVAC system is working properly, nor should he be.

**Matching the Symptoms with the Possible Causes**

Most health complaints begin with one or more workers who decide that the office is creating health problems. At the outset, they have made their own diagnosis and have determined the cause. As often as not, this attribution is incorrect, and it is important for the investigator to understand this.

However, it is especially important to realize that once a belief is firmly in place, it may be hard to dislodge, and indicative attempts to do so may create resentment and distrust. In other words, you had better have good data as well as a caring manner when discussing with workers potential causes for their problems, which may differ from what they have come to believe.

**Figure 3.1. Symptoms and disorders commonly related to the office environment by workers: A chaotic mixture**

**Headache**

- Stress
- Eyestrain
- Migraine
- Neck strain

**Rash**

- Insect bite
- Eczema
- Contact dermatitis (dust-related)
- Other skin disorders

**Eye irritation**

- Conjunctivitis
- Allergies
- Infections

**Nosebleeds**

- Allergies
- Infections

**Fatigue**

- Many minor changes
- Depression
- Sleep deprivation
- Chronic fatigue syndrome

**Miscarriages**

- Idiopathic
- Various factors

**Effective Triage**

Symptom complaints are often minor and may respond to simple adjustments in airflow from the HVAC system or small changes in temperature and/or humidity. These are obviously simpler solutions than bringing medical and engineering consultants into every office in which workers have complaints. The challenge is for the first consultant on the scene (often the building maintenance staff) to do an effective triage or initial assessment; that is, to determine when a problem is trivial or serious and to recognize and respond quickly to any escalation. The key qualities needed in such a person to serve these functions well are common sense, understanding manner, and sufficient awareness of the possible underlying causes of complaints. Independent assessments by outside consultants are generally not required in the majority of complaint situations. Nevertheless, consultants can serve as a sounding board or provide independent confirmation of an in-house assessment. Should a situation deteriorate, however, ready access to the appropriate consultants can be critical.

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**Table 3-2. Possible causes of symptoms and disorders often attributed to IAQ.**

<table>
<thead>
<tr>
<th>Symptom or disorder</th>
<th>Common causes</th>
<th>Office-related possible causes</th>
<th>IAQ possible causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>Stress</td>
<td>Stress</td>
<td>Rarely chemicals</td>
</tr>
<tr>
<td></td>
<td>Eyestrain</td>
<td>Eye strain</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Headaches</td>
<td>Psychosocial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Migraines</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neck strain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rash</td>
<td>Insect bite</td>
<td>Neurotoxicosis (dust-related)</td>
<td>Fiberglass</td>
</tr>
<tr>
<td></td>
<td>Eczema</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contact dermatitis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other skin disorders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baby eyes</td>
<td>Congestion</td>
<td>Eyestrain</td>
<td>Low humidity</td>
</tr>
<tr>
<td></td>
<td>Allergies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Infections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newborns</td>
<td>Allergies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Infections</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tear stains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue</td>
<td>Many minor changes</td>
<td></td>
<td>Possible (diabetes)</td>
</tr>
<tr>
<td></td>
<td>Depression</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sleep deprivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chronic fatigue syndrome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscarriages</td>
<td>Idiopathic</td>
<td></td>
<td>None known</td>
</tr>
<tr>
<td></td>
<td>Various factors</td>
<td></td>
<td>None known</td>
</tr>
<tr>
<td></td>
<td>Classic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Structural</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medication</td>
<td></td>
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</tr>
</tbody>
</table>

**Table 3-2. Continued**

<table>
<thead>
<tr>
<th>Symptom or disorder</th>
<th>Common causes</th>
<th>Office-related possible causes</th>
<th>IAQ possible causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>Allergies</td>
<td></td>
<td>Rarely known</td>
</tr>
<tr>
<td></td>
<td>Cat</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dog</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dust at home</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paints</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bic.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exercise induced</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cold air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cancer</td>
<td>Smoking</td>
<td></td>
<td>None known</td>
</tr>
<tr>
<td></td>
<td>Heredity</td>
<td></td>
<td>None known</td>
</tr>
<tr>
<td>Trouble concentrating</td>
<td>Many serious stressful</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boredom</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depression</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overwork</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chronic fatigue syndrome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fainting</td>
<td>Blood</td>
<td></td>
<td>Major chemical injury (i.e., carbon monoxide)</td>
</tr>
<tr>
<td></td>
<td>Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Atherosclerosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heart disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anxiety</td>
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(continued)
Because situations are so varied, there are no absolute triage rules that can be applied universally. However, several important clues and rules of thumb can help guide appropriate action.

Triage considerations are twofold. The first aspect might be called the who question. Who should do the investigation and work at resolving the problem? The second is the what question. What needs to be done to address concerns and resolve the problem?

One rule is that the development of indoor environmental complaints over time is unpredictable. What starts as a seemingly minor problem can become a nightmare, or what begins with explosive outbreaks may fizzle. Secondly, building managers and owners can get into trouble by either doing too little or doing too much. Failing to recognize the potential severity of a problem, minimizing people's concerns, or responding too tentatively can increase anger, distress, symptoms, and financial risk. Conversely, overreacting at the first notice of a complaint can produce data that have no meaning or unleash frightening hazardous material (Hazardous Material Assessment Team) responses, both of which lead to heightened anxiety, expensive remediation, and psychologically induced illnesses.

Because of the risks just described, one should be clear. Whoever is entrusted with the preliminary evaluation of these complaints needs to understand the risks, have good common sense, and be an effective communicator. The management of perceived indoor air issues is half a technical function and half public relations. If these traits can be found in someone in the building-maintenance department, then that individual may be the appropriate initial contact. If on the other hand the building-maintenance department has no such individual, then the owner and managers would be well served to involve a consultant immediately. In either case, the need to have an IAQ plan in place before problems arise cannot be overstated.

Decisions about how to proceed with an investigation and what level of investigation to undertake are determined by a number of factors. The levels of investigation will be discussed in the next section. The relevant factors include the severity and nature of symptoms, lost work time, attributions made by employees, the number of people complaining, how long the problem has been going on, what has been done to address the problems thus far, whether consultants have been involved, and the quality of the landlord-tenant relationship.

Severity and Nature of Symptoms

The very first question that must be asked and answered is, "How sick are people?" Obviously, there is a difference between loss of consciousness or hospitalization for Legionnaires' disease and complaints of headaches. The first two may require evacuation of the building and primary attention to health needs. The second generally permits a more measured and systematic response. Severe

(e.g., too hot, too cold, or insufficient humidity), the situation may be manageable at the facility level.

On the other hand, if workers are using terms such as "sick building," "poisoning," or "toxic," this implies a potentially more difficult-to-manage situation. The more dangerous the situation is as the eyes of the workers, the more complicated the resolution of the problem. The triage question is then "What do people think is wrong?"—a question that should also be asked of workers on an individual basis.

Number of People Complaining

Complaints from only one or two people may be more easily managed than a company-wide problem. It is important to remember, however, that symptoms may herald an early health problem that can become more widespread and that symptoms can be contagious through the psychology of suggestion; one or two complaining workers can quickly spread their symptoms to others. Thus, it is important to respond in a caring and competent manner even when there is just a single complaint. The most intense response will be stimulated by situations with the most complainers.

Duration of Problem/Involvement of Other Consultants

A critical role of triage is that the longer the problem has existed, the more resistant it will be to correction. In addition, sometimes the building owner/manager is the last one called. The tenants have brought in their own consultants who have been unsuccessful in resolving the problem. Problems that are firmly entrenched generally require sophisticated and experienced problem solvers.

Quality of the Tenant-Management Relationship

Indoor air allegations are a growing source of leverage in landlord-tenant disputes. It is not uncommon for leases to be broken based on "bad air," and tenants have brought major lawsuits against landlords for such problems. In some cases tenants have trumped up "bad air" allegations in order to terminate a lease. I have personally investigated at least one such matter. Recognizing this, if you are a building owner or manager, the quality of your relationship with your tenants becomes an important triage issue. If the relationship is bad, or if indoor air complaints follow a series of other problems, consider early expert consultation rather than simple fixes.

Investigation

The bottom line of any investigation is to make the workers feel more comfortable—to take their symptoms away. Sometimes this can be done without a complete understanding of the reasons that they have symptoms; a minor adjustment may be all that is needed. At other times, the investigation of health complaints and their causes requires a systematic multi-stage process. In these instances, symptoms must be evaluated, the environment must be evaluated, and the two must be correlated as accurately as possible. While it is important to say that an engineer cannot definitively determine the cause of someone's headache or other symptoms, some workers concerns may be adequately addressed and solved by an engineer. Thus, if a worker feels that the air is too dry, a limited and focused evaluation of building humidity and correction where indicated is the most cost-effective and logical approach.

To simplify our organizational discussion, we may consider three levels of investigation. The level required will be dictated by the triage considerations identified in the preceding section.

Level 1

At its simplest, an indoor-air investigation involves an unoccupied inspection and minimal corrections. When triage suggests a minor problem, then that is what should be addressed. It may be accomplished without sophisticated consultation or medical input. It may involve implementing simple operations and maintenance plans, minor cleaning of the HVAC system, adjustments to airflow, temperature, humidity, or lighting. For example, workers might express concerns about localized mold growth. Cleaning the mold and adjusting the humidity may suffice.

Level 2

The second-level investigation requires more intensive analysis. Here there may be more health complaints, and triage may suggest a more serious problem. At this level appropriate consultants need to be engaged. These consultants must have the skills, knowledge, and expertise to solve complex problems involving engineering, industrial hygiene, and medicine—the three disciplines that are central to the evaluation of indoor environments and health. At Level 2, a more intensive search for causes is in order and should include medical interviews, evaluations of occupational stressors, and facilities evaluations. Sampling for airborne contaminants is generally not performed unless indicated by point source evalu-
tions; rather, general HVAC issues are evaluated and potential point sources of contaminants are reviewed (Perry, 1994; ISIAQ, 1996; Ventresca, 1995).

Level 3
The most intensive evaluation occurs at Level 3, where all of the expertise and evaluations noted previously are performed, but comprehensive environmental sampling and laboratory analysis may be ignored. A summary of the critical elements of this level of investigation are shown in Table 3–3.

A comprehensive discussion of these phases is beyond the scope of this chapter; some general descriptions are provided.

Complaint Evaluation
Complaint evaluation is the process of cataloging the worker's symptoms and their associated causes. For it also includes as part of the differential diagnostic process) asking about other factors, including home environment, prior allergies, and job satisfaction. In general, widely distributed questionnaires, while commonly used, are not a good idea. Unless they are extremely well constructed (few are) and poorly administered, they can produce leading questions and can make any building look sick (Gots, Gees, and Spencer, 1992; ISIAQ, 1996; Quinlan et al., 1989; Samimi, 1993). Brief interviews are strongly recommended. After reviewing complaint records, interview a representative number of complainants and noncomplainants. Additionally, occupants (complainants and noncomplainants) may be asked to maintain a diary of environmental conditions and their personal events. Complainants tend to keep more detailed diaries, and although this would be considered a bias in a formal scientific study, in a com-

Table 3–3. Phases of a comprehensive (Level 3) investigation.

| 1. Complaint evaluation |
| 2. Clinical evaluation |
| 3. Source evaluation |
| 4. HVAC evaluation |
| 5. Sampling (if necessary) |
| 6. Causation analysis |
| 7. Communication (this applies to levels 1 and 2 as well) |

Causation Analysis
Causation analysis in this case refers to the process of putting environmental data together with clinical data to reach cause-and-effect conclusions. Often this at-
tempt is made by individuals with no relevant medical expertise who then draw incorrect conclusions. For example, HVAC engineers may find poor air/ductwork distribution in an area and conclude that it caused the reported symptoms. If symptoms include skin rashes, this conclusion is wrong, because airflow problems do not cause skin rashes. Or an industrial hygienist may find very low lev-
el s of a variety of volatile organic chemicals and conclude that they caused headaches, when they could not have done so. Or a small amount of visible mold may be blamed for respiratory complaints despite the fact that the suffers were not allergic to that mold.

This process of causation analysis is the most sophisticated part of the invest-
gation, for it goes beyond data collection and into differential diagnosis and clinical interpretation. Many engineers and industrial hygienists do this very poorly, but too many physicians who are unfamiliar with the health issues associated with office buildings. That is why a multidisciplinary team approach that includes consultants with indoor air expertise is so important.

Communication
Communication is listed last, but it is not the least of the phases. Rather, effective communication must be a continuous process. From the start, workers need to understand the investigation process itself. Throughout every phase of the pro-
dure, the workers need to know that explanations are being sought and relief is on its way. This awareness of the investigative activity is extremely important; it may determine how smoothly and inexpensively the situation is resolved. Occup-
ants who are involved in and informed about the investigation are more willing to accept and more likely to understand investigative conclusions and recom-
manulations. Dissatisfied workers who feel sick and worried and who do not be-
lieve they are being heard or understood can quickly become a large group of plaintiffs.

Effective communicators need to be good listeners, but they also must have the expertise needed to gain and maintain credibility as well as the trust and re-
spect of the workers. In other words, they must be honest and believable. This communication component may be the single most important part of the inves-
tigative process. If the facility-management team or the chosen consultants cannot communicate effectively, then someone who can should be brought in to fill this role.

Finally, an environmental evaluation may and often should proceed simulta-
neously with the medical evaluation. However, it must be recognized that such investigations often identify factors that have no causal relationship to symp-
toms. For example, an HVAC system may be found to be unhealthy, but that may not be the cause of people's headaches. Only when there is a careful interac-
tion between medical evaluators and environmental investigators can such causal connections be accurately made. And only when results and activities are effec-
tively communicated will problems be resolved with minimal adverse conse-
quences for the organization.

EVALUATING AND CHOOSING CONSULTANTS

Popular concern about the quality of our indoor air has given rise to an explosion of "experts" and consultants, from engineers to duct cleaners to physicians, all ready to proclaim buildings and their occupants sick, to builders ready to charge thousands to millions of dollars to fix things. Entrepreneurism surrounding a new issue of public concern is neither new nor inappropriate. However, when it misrepresents health risks and wastes of health and productivity, it de-

mands control. "The building is sick" has become the proclamation of purveyors of expensive, unnecessary services.

Any responsible party—building owners, managers, insurers—confronted with such complaints must exert great caution in selecting a consultant or envi-
ronmental group to assess the problem. Quite frequently, these consultations and surveys produce more questions than answers and generate data that may appear meaningful but have no toxicological significance. Left uninterpreted, these data may both intensify worker anxieties and contribute to financial liability.

A significant impediment to the effective handling of such complaints arises because of the diversity of professionals involved in the relatively new area of indoor air quality. For example, environmental engineering firms may be prepared to measure substances in indoor air. Lacking toxicological or medi-

cal expertise, however, such firms may be ill-equipped to interpret the potential public health effects of their findings. Even less frequently are they able to deal with the complaints of specific individuals within that working environment. Because they are neither effective communicators nor health professionals, they cannot respond effectively to the concerns of the workers. This may leave the employer or building manager with a set of data with no meaning, and with no plan of action. It is far easier to collect data than to interpret or act upon the information.
Because such investigations involve merging health information and analysis with environmental and engineering assessment, these investigations are of necessity multidisciplinary. Engineers and environmental specialists cannot evaluate health complaints. Medical specialists, without environmental expertise, cannot evaluate the environment. However, because complaints often begin with symptoms, a primary focus of the health investigation must start with symptom evaluations. Thus, once the situation has demanded the acquisition of outside consultants, those consultants must have sufficient medical expertise to assess symptoms. This is important not only because this method is the most likely to succeed, but also because it minimizes liability. How would it appear to a jury if, after someone claimed that the building caused a serious illness, the building manager could not demonstrate how the building’s systems caused the illness? Ultimately, this medical expertise will include physicians, but at first it may be provided by nurses or industrial hygienists. A consulting firm that fails to involve these experts early and that has no readily available medical advice should be avoided.

Ask the environmental firm a few basic questions before hiring it to conduct an EAA health investigation:

- Who is in your organization has medical expertise?
- What physicians do you use?
- How do you define a sick building?
- What do you measure? For example, for each chemical, fungus, mold, or bacteria that you measure, what are specifically identified indoor air problems? What will you compare your numbers to for interpretation?
- If you identify indoor air problems and a correctable solution in them, do you have a program to correct them? If measurable levels of contaminants are in normal ranges, will you then tell me I do not have a sick building?
- Will you meet with the workers to discuss your findings and answer their questions about the health effects? Who will do this?
- Is it possible to satisfy all building occupants?

Those responsible for the quality of building-occupant health and safety must clearly recognize the difference between work complaint and a proven air-quality problem. Of course you must investigate, but before doing so you must understand the significance of the allergy-related investigation and must question the firm conducting the studies about the significance of potential findings and the expertise of those involved. A key means of assessing consultants’ skills is to contact references whose problems the consultants have addressed and solved. Do not embark on a complex regulatory mission of this kind without such a background review.

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Case 1

In 1992 air quality consultants forced immediate evacuation of a courthouse building in Florida, proclaiming that mold growth posed a cancer risk to occupants. Built in 1989, the building cost $11 million to construct. The renovation, owned by those same consultants, cost $9.5 million. Litigation alleged personal injuries of the building occupants and sought to recover the cost of damaged property. It is true that there was mold. There is mold in all buildings in some form. But has there been any structural problems? It is not true that this posed an imminent or immediate threat to the employers as the consultants claimed; nor was it necessary to spend $9.5 million to rebuild this building. After far more modest repairs and cleanup would have sufficed. This kind of irresponsible misuse of expertise can cost millions of dollars in inappropriate expenditures (as it did in this instance).

The lesson learned: when choosing consultants, it is important to find individuals who think responsibly and use good judgment and common sense to help their clients. Asking “what if” questions will help sort out those who have extreme views from those who are more rational. Getting references is essential. As beware of conflicts of interest. Consultants should not profit from remediation.

Case 2

In a school district in central Pennsylvania, an asbestos-abatement program included removal of asbestos from tiles with a petroleum-based chemical solvent. By the time this author got involved, intense emotions had gripped this community, resulting in polarization. The school board was seen as unscared and ac

case studies

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Summary

Confronting indoor air health complaints can be a daunting experience, even for experienced experts, let alone for a novice building manager or engineer. The purpose of this chapter was to provide a basic understanding of the causes of health complaints and the approaches to resolving them. Essential messages to derive from this discussion include understanding the severity of the situation to decide when sophisticated help is needed; knowing what to expect of consultants and how to evaluate them; recognizing the critical importance of both psychological and physical factors; and understanding why common sense, excellent communication skills, and the ability to react appropriately—neither overreacting nor underreacting—are the keys to a successful resolution.

References


Chapter 4

Indoor Air and Health: Clear-Cut, Equivocal, and Unlikely

RONALD E. GOTS, M.D., PH.D.

Introduction

This chapter addresses the medical and causal links between common symptoms and the phenomenon of indoor air quality (IAQ) concerns. From a medical perspective, several of the health effects people often claim are related to indoor air are not legitimately causal, nor do these effects follow the pattern of clinical diagnosis used in medicine for many years. The author recognizes that well-intentioned and sincere advocates for other views do exist, but this chapter reflects on the findings of medical research papers and the author’s own clinical experiences.

The central dilemma in IAQ cases is the differentiation that needs to be drawn between actual diagnosis of clinical illness and the physical complaints that are due to perceived environmental threats. The distinctions between the two are often elusive. IAQ complaints tend to expand beyond the ability of medicine to identify a particular physical cause.

Epidemiologists who track the occurrences of illness have added considerably to medicine's understanding of indoor air illness issues. Although between 500 and 5,000 buildings have been studied for these claims, relatively few of these investigations have led to clear conclusions. The process could be implemented into an effective corrective action (Sulik, 1990). A study by an expert team (from Johns Hopkins University's School of Public Health found that identical symptoms were reported from two comparable buildings, one of which had been identified as a "sick" building by some occupants while the other had not. The only difference was that the "sick" building had generated a lot of responses from the
occupants. These responses were common complaints such as headaches, but their frequency of attribution in the building was a distinction from the normal rate (Corn, 1991).

Several factors have coalesced in the study of the confusing phenomenon of indoor health effects:

1. More effects can be measured than can be explained. The detectable presence of chemicals and biological contaminants has become more evident as analytical tools have dramatically improved in recent years. Yet the tools have improved faster than our ability to use them in making scientifically defensible risk-management decisions. Some detectable contaminants are relevant to medical evaluations; some are not.

2. Because common symptoms of everyday life such as headaches, fatigue, and noise and eye irritation are the symptoms most likely to be alleged in IAQ complaints, diagnosing the physical problem is simple, but discovering its cause is not. In the patient's mind, the particular building is the culprit. Medical evaluation is made more difficult by such a perception.

3. Solutions to medical related symptoms tend to be diluted according to the number of different disciplines from which the problem solvers are drawn. As these experts have involved microbiology, industrial hygiene, engineering, architecture, public health and manufacturing chemistry issues, the likelihood that solutions will come piecemeal or in divergent directions is much worse than if one "big picture" solution were available. Medical personnel will need to coordinate their work with the efforts made by advisors from other fields.

4. Beliefs outpace data; perceptions become reality. Fear of the effect of a building expands, even if the data to support that belief does not exist or has been actively rebutted by measurements.

INDOOR AIR'S SCIENTIFIC DEBATE

The medical community relies on research findings and retrospective evaluations of data. In some buildings, a harmful effect existed and caused illness or death. The classic example is the bacterial contaminant that spread via the ventilation system of the Philadelphia hotel where American Legion members were attending a conference. The spread of the Legionella bacteria was a well-studied effect from a clear culprit. The 182 persons who became ill and the 29 who died were in fact killed by a hazardous building.

The debate over building materials and their effects on occupant health gained momentum during the late 1970s, when urea-formaldehyde foam insulation (UFPI) was being challenged. UFPI was eventually banned by the federal government for several millions of dollars in damages.

The study of indoor air-related disorders is sufficiently new and heterogeneous that the terminology is unclear. "Sick building," "tight building," and "building-related disease" are used interchangeably. Now a new term, building-related occlusion complaint syndrome (BROCS), has been coined, adding further confusion to this field. Most commonly, the scientific literature places several building-associated conditions into separate categories. These include building-related diseases, tight building or sick building syndrome, and building-associated symptoms. Perhaps BROCS will soon incorporate the latter two terms.

More recently, new terms describing alleged chronic health effects have arisen. These include multiple chemical sensitivities, toxic encephalopathy, reactive airway dysfunction syndrome (RADIS), and occupational asthma.

Building-Related Diseases

Building-related diseases are disorders, ranging from mild to severe, due to specific, identifiable contaminants of indoor air. For a classification of building-related disease to be designated, clear and convincing evidence must exist that something in the building is causal; preferably, the agent should be known. Moreover, the disease or end point of the disorder must generally be quite clear, not merely a set of nonspecific complaints. It may be death or serious disability, with Legions airs disease. It may be an epidemic of influenza passing through a workforce. It may be an occupational asthma proven by immunological studies of the patient and correlated with cultures of the causative organism, perhaps found in the building's ventilation system.

Legionnaires' disease is an example of a medically determined linkage between a building or illness and the building itself in a particular context. There are other organisms, commonly fungi, molds, and thermophilic bacteria, that contaminate heating and air-conditioning systems produce a variety of complaints and disorders—generally mild hay fever types of allergies, but at times more serious conditions such as asthma or hypersensitiviy pneumonitis.

Other common infectious diseases, like colds and influenza, are easily spread by ventilation systems. In a study comparing Army recruits living in "stark" barracks to those living in "light," more efficient barracks, the latter group had a higher frequency of colds (Brumfield et al., 1988). When a large percentage of the workforce becomes ill from such infectious diseases, building-related diseases can be suspected, although it may be difficult to find a specific contributor in the building environment itself.

It is certainly reasonable to assume that confined spaces with poor outside ventilation would be an environment conducive to the transmittal of respiratory viruses. How and whether that translates to illness in more open and larger office buildings is, however, not established by medical evidence.

Sick (or Tight) Building Syndrome

The term sick building syndrome, or tight building syndrome, has been applied to situations in which workers have many and varied symptoms without many potential causes of those symptoms makes the term misleading. Hodgson and Cahn argued that this term should be abandoned (Cain and Cemoit-Mohltz, 1995; Hodgson, 1995a; Hodgson, 1995b). I agree, because the term leads to the false sense that groups of people in offices with tight buildings have those symptoms because of some problem with the indoor air quality. However, since the term is so common, I will use it in this chapter.

The term sick building syndrome indicates that people in a workplace either are not feeling well or have health complaints, but it does not explain why. It implies that a significant percentage of building occupants complain of a variety of building-related symptoms such as eye and mucous membrane irritation, headaches, fatigue, and sinus congestion. Furthermore, it requires a substantial at-
tack rate (involvement by 20 percent or more of building occupants), a temporal relationship to the building, and improvement with specific corrective measures. This term also implies that problems with indoor air, generally related to poor air exchange in energy-efficient buildings, have been identified. Unlike building-related disease, with sick building syndrome a specific agent such as bacteria or molds is rarely found. It suggests a building-related cause whether or not such a cause exists. People’s symptoms may be due to a specific contaminant, but they also might arise from workers’ stress or from poor ventilation in an area—what used to be called “stuffy air.”

Today, in our body- and health-conscious society, people closely monitor their physical sensations and symptoms; thus symptoms that are merely the result of stuffy air become a building-related complaint. It has also been noted, with some merit, that energy-efficient buildings constructed after the early 1970s have sealed internal environments, permitting a variety of contaminants to linger and accumulate; when formerly they would have migrated to the outdoors. While it is clearly true that modern buildings are more tightly sealed, it is not clearly true that indoor air today is worse than it used to be. For example, in this country there are vastly fewer smokers now than in 1965. Conference rooms in office buildings during that era were filled with cigarette and cigar smoke (hence the expression “smoke-filled rooms”). In retrospect, what could be more disturbing to occupants than the hundreds of irritating chemicals emitted by tobacco smoke? The indoor air environment was much more contaminated with secondary tobacco smoke than today’s indoor air, whereas today unfast and often unscented chemicals are the focus of intense concern. The contrast bears consideration.

**MEDICAL INVESTIGATION OF CAUSATION**

Because sick building syndrome is associated with nonspecific symptoms and is dependent on subjective individual manifestations for its identification, its causes—air contamination or psychological factors—cannot easily be distinguished. Other investigations have been conducted (Sears, 1981). Moreover, over, as reporting of indoor air problems has become more frequent, there will be increases in psychological influences and reporting biases. The only way to approach some semblance of true scientific investigation is through controlled, blinded studies in which air concentrations are varied, unknown to building occupants, and a symptology is subsequently reassessed. The few instances in which this was attempted found mixed results regarding the relationship between air exchange rates and contamination levels and symptoms (Baldwin and Parant, 1990; Collet et al., 1991; Parant et al., 1990; Parant et al., 1992; Menzies et al., 1990; Menzies et al., 1993; Nagda et al., 1991; Palonen and Seppanen, 1990).

Another investigation measured a number of environmental characteristics, including thermal parameters (dry-bulb temperature, relative humidity, air speed, and radiant temperature), volatile organic compounds, respirable suspended particles, lighting, and lighting stress. It was unusual for all sensory contammation from clerks, clerks, or humidifiers (secondary to the ventilation from local or central induction fan coil units had more symptoms than buildings with all-air ventilation systems, which in turn had more symptoms than naturally or mechanically ventilated buildings. According to this study, microbiological contamination from clerks, clerks, or humidifiers (secondary to the ventilation system) can result in some of the worst symptoms, probably by an allergic or endocrine-related mechanism (Burg et al., 1987).

**BUILDING-ASSOCIATED SYMPTOMS**

The term building-associated symptoms is the most frequent group of building-related conditions or complaints. Here, occupants of a building complain of various symptoms, which they associate with the building. Intensive investigation is unable to elevate a specific cause and, in the possible case of no speculation. Much of what has been termed sick building syndrome is probably better called building-associated symptoms.

**FACTORS IN THE WORKPLACE THAT CAN PRODUCE SYMPTOMS**

Because we are dealing with an ecologic group of symptoms and disorders, their causes are multifaceted, ranging from purely environmental factors to infectious viruses and bacteria. Clearly, as perceptions of bad indoor air increase, environmental factors grow in importance. It becomes increasingly difficult to sort out the real culprits and to separate symptoms due to perceptions from those due to bona fide contaminants. Following is a brief discussion of some of the specific ambient factors in indoor air that may affect levels of comfort and contribute to symptom complaints. We have already discussed factors such as bacteria, which may cause serious diseases, and have considered psychological factors that may cause or intensify complaints.

**Ventilation and Related Factors**

When researchers seek a cause of sick building syndrome, they most often study the type and quality of building ventilation. But when we read the studies, we see a lot of doubt and little conclusive evidence about whether ventilation alone can explain

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Odors are among the most important causes of health complaints in the indoor environment. Symptom-producing odors often accompany remodeling or renovation projects; workers smell the chemicals associated with these activities and associate them with risk or danger. The result is symptomatic sick workers.

Emotional Causes and Mass Psychogenic or Sociogenic Illness

The increased awareness of chemicals in the environment and media attention on indoor air issues have bred a greater tendency for people to aggra- vate, and even cause, outbreaks of illness in the workplace. Psychological issues outside the workplace and stresses within it may result in some of the symptoms, such as headache or lethargy. The use of the term sick building syndrome is an emotionally charged issue already. Research is needed to develop scientific criteria for distinguishing between illness arising from psychological factors and symptoms resulting from exposure to indoor air pollutants or toxic substances (Lutz, 1990). Many incidents of epidemic anxiety and mass hysteria have also been reported. These incidents sometimes begin with a remediable indoor air problem; at other times they can be traced not to a building problem but to “problem” individuals. In one acute epidemic, several hundred employees in a state office building in Missouri complained of headache, mucosal irritation, fatigue, odd taste, and dizziness. Extensive investigations revealed no toxic substances or discrete cause of the illness. One interesting finding was that the employees who complained of illness were more likely to have perceived unusual odors and inadequate airflow. In any event, investigators concluded that a state of epidemic anxiety was triggered by negative factors in the environment, including poor air quality (i.e., crowding, blocked vents, smoking, high temperatures). Reports of illness from coworkers, arrival of emergency vehicles, and evacuation of the building probably led to the escalation of the event (Donnell et al., 1989).

In another similar incident, operators in a telephone-company building reacted to what they reported was a strange odor with symptoms of headache, nausea, throat irritation, and even respiratory distress. The incident dragged on over an entire month, with evacuations and inspections by California Occupational Safety and Health Administration (OSHA) officials, the local fire department, and the county hazardous materials team. No evidence of toxic fumes, gases, chemical leaks, or spills could be found, and all of the people taken to hospitals were found to be asymptomatic, with normal laboratory results. The investigation then turned to one individual who in fact had spread the epidemic as he moved from one part of the building to another with reports of noxious odors that he interpreted as petroleum distillate poisoning.

Here, too, the hysteria escalates as emergency vehicles arrived on the scene and workers witnessed fellow employees in respiratory distress (Alexander and Fedoruk, 1986).

Often, investigations do not reveal a specific causal agent, even with careful monitoring of air contaminants. Because symptoms often disappear with improvements in ventilation or when individuals leave the building, it is difficult to know whether there is a physiological basis for the illness or whether it is a case of mass hysteria or psychogenic illness.

Products of Combustion, Including Tobacco Smoke

Combustion products are sometimes implicated in building-related illnesses, particularly in cases of respiratory effects. These products consist primarily of carbon monoxide (CO), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂). Sources of these compounds are tobacco smoking, gas ranges, pilot lights, unvented kerosene space heaters, wood and coal stoves, fireplaces, and vehicle emission exhaust.

The contaminant that probably has received the most publicity is environmental tobacco smoke (ETS), also called passive tobacco smoke (PTS), which refers to its effects on non-smokers. Exposure from passive smoke is mainly sidestream. Though sidestream smoke may have higher concentrations of some toxic and carcinogenic substances than mainstream (active) smoke, it is diluted by room air.

The most consistent and conclusive findings have shown that for children, and particularly for children of parents who smoke, PTS increases the occurrence of respiratory illness and chronic respiratory symptoms such as bronchitis, pneumonia, and emphysema (Samet, Marbury, and Spengler, 1987a and 1978b). The health effects of PTS on respiratory symptoms and infection in adults have not been as well studied, and the subject remains controversial. Studies of the association between passive smoking and lung cancer in adults are also inconclu- sive; case-control and cohort studies do not uniformly indicate increased cancer risk. However, the International Agency for Research on Cancer of the World Health Organization (WHO), the National Research Council (NRC), and the United States Surgeon General have all concluded that involuntary smoking is a respira- tory carcinogen (Samet, Marbury, and Spengler, 1987a).

Less evidence exists for adverse health effects of some of the other chemical compounds listed here, like sulfur dioxide, partly because they occur infre- quently in the indoor occupational environment. For example, though the effects of acute carbon monoxide poisoning by suppression of consciousness are known, health effects at low levels, and particularly those resulting from chronic exposure, are less well documented. Nitrogen dioxide occurs during combustion of gas during cooking and is emitted from burning pilot lights; exposure is usually residential. The magnitude of respiratory illness resulting from exposure to NO₂ is usually small (Samet, Marbury, and Spengler, 1987a).

Automobile exhaust makes people feel ill because of odors, carbon monox- ide, and irritants. At times, buildings complaints occur where air-intake systems are near or in garages or carports, permitting exhaust fumes to enter the building.

Formaldehyde, VOCs, and Other Chemicals

Medical evaluation of some air complaints is difficult because physicians cannot correlate worker symptoms with the measured levels of chemicals detected in the workplace air. The science of measurement has become very sophisticated, enabling us to detect indoor air contaminants at extremely low levels. Investigators conducting such measurements find hundreds of chemicals around us all the time at these levels. Residential air, building air, outdoor air, air worldwide contains such materials. According to a 1989 report by WHO’s Committee on Indoor Air Quality, “... the indoor organic air pollutants as reported from several large surveys are similar in the distribution of concentrations in residential environments in several industrialized countries” (WHO, 1989). That study discussed 73 chemicals commonly found in indoor air worldwide.

Thus it is quite easy to identify substances in indoor air. And these substances’ complex and frightening organic chemical names (e.g., hexane, formal- dehyde, benzene, trichloroethylene, 1,1,1-trichloroethane, methylene chloride) raise concerns in both those who believe that a building is causing their illness and those who are ultimately responsible for the building. Health effects of chemicals at these low levels, however, are often nonexistent or unknown.

For example, a common indoor air complaint is irritation of the nose and eyes. "Organic compounds do produce mucosal irritation and other morbidity, though usually at orders of magni- tude above the measured concentrations noted indoors." Indoor air contamin- ations of identified substances are of overall health effects, thus than those known to produce health effects. OSHA frequently permits workers in industries that use or manufacture those chemicals to expose levels to hundred or so thousands of times higher than those found in buildings with no established profes- sional health effects.

Critics of this disparity point to differences in job requirements, such as in- tense cognitive functions needed in offices, and differences due to such things as "healthy worker effect" in which industries weed out sensitive workers. Though these and other arguments may be valid, there is little proof that they are.

To some extent, these arguments become rationalizations for people seri- ously committed to the belief that indoor air in modern buildings is uniformly...
bad and is producing significant health problems. Thus, frequently levels of chemicals in buildings in which workers complain have occurred are no higher than customary background levels found in homes, shopping malls, and neighborhood restaurants. Invariably they are vastly lower than permissible exposure levels in manufacturing facilities. This leaves investigators with data that identifies chemicals but cannot correlate those levels of chemicals with the workers' symptoms.

Numerous chemical compounds may contribute to indoor air pollution. These include volatile organic compounds (VOCs), asbestos, radon, carbon monoxide, and a category of complex mixtures of VOCs that are typically found in new buildings. Certain questions arise regarding these chemicals and their role in indoor air quality. We need to know in any given instance whether the chemical (or chemicals) is (are) a proven cause of the illness; (b) whether the levels at which the chemicals exist in the environment are known to cause the illness or symptoms; and (c) what scientific methods have been used to measure the chemical levels, document symptoms, and prove causality.

Formaldehyde was used in UFFI until that product was banned; it also has numerous sources in the home and office—particleboard, paper products, floor coverings, and carpet backing are among the sources, albeit in very small amounts. Reported levels of formaldehyde in office buildings have ranged from 0.01 to 0.30 parts per million (ppm), all well below the OSHA standard of 0.75 ppm. Less is known about the levels in buildings where occupants were reported to have symptoms. The most recent studies indicate that levels are usually less than 0.1 ppm, and reports of irritation of the eyes and upper respiratory tract have occurred at levels above 0.1 ppm. The disparity between the OSHA standard and levels of reported symptoms should be noted. Formaldehyde has been associated with respiratory and neurobehavioral effects (at lower levels than OSHA permits), but this has not been proven. Published studies have been biased with regard to subject selection and data collection; further investigation is needed (Letz, 1995).

VOCs from a category made up of many different compounds that have been identified in indoor air. As the technology for chemical analysis improves, we will have an increasing ability to identify trace amounts of these compounds. In a large-scale series of NIOSH investigations, 350 VOCs were identified in concentrations greater than 0.001 ppm. This does not mean that they exist in greater amounts than they did five years ago, or that exposure is greater, or that there is more danger from them, but simply that our techniques for detecting them are better. In all cases, the measured levels of VOCs were within a factor of 100 of OSHA's permissible exposure levels. Measured levels of VOCs were almost all below 1 ppm and below levels for acute symptoms in humans (Letz, 1995).

With VOCs, as with other chemicals that may affect IAQ, conflicting or incomplete scientific evidence of toxicity at low levels makes medical evaluation more difficult. Other studies, for example, found small samples of healthy individuals, when exposed for a short time to VOCs, experienced subjective symptoms such as headache and general discomfort but did not show any decreased performance on behavioral tests (Oto, 1992).

To the contrary, two other studies found that subjects exposed to organic solvents showed both cognitive deficits and psychological disturbances (similar to posttraumatic stress disorder) on standardized tests. But nowhere in the studies is information given on the levels and intensity of exposure—information we need to compare the levels to those of the same chemicals in indoor air. These studies, then, should not be used as the basis for concluding that low-level VOCs cause neurobehavioral disturbances (Molhave, 1992; Molhave, Bach, and Pedersen, 1986; Morw et al., 1989; Mowen et al., 1990).

**Chronic Illnesses Alleged to Be Caused by Environmental Factors in Office Buildings**

Four potential long-term or chronic illnesses have been blamed on indoor air. Most of these have arisen in the context of claims of injuries from the workplace. In almost all cases (with a rare exception to be discussed later), these illnesses do not actually occur from office exposures: yet the claims allege office illnesses.

One reason that such claims are made is that sick building disorders and building-associated symptoms are self-limited, relatively mild problems that do not cause long-term dysfunction or disability. This lack of medical significance does not support the claims of medical damage that are sometimes made in a lawsuit.

**Multiple Chemical Sensitivities or Idiopathic Environmental Intolerances**

A certain percentage of individuals claim that they are permanently sensitive to all chemicals, and hence disabled, as a result of exposure to something in the workplace. Paints, carpeting, pesticides, copy-machine toner, car heater, and paper copy, and standard cleaning chemicals are among the materials that have been blamed by those who view themselves as permanent victims. The claimants are often supported in their belief by a variety of medical practitioners who are equally strong in their beliefs (U.S. EPA, 1996; Gots, 1995). There is, however, no standard or recognized clinical definition for this condition, and no tests, studies, or other objective or reproducible criteria exist with which to make the diagnosis.

In 1985 Dr. Mark Callie, a professor of occupational medicine at Yale University, named this condition multiple chemical sensitivities (MCS) (Callie, 1987).

**Toxic Encephalopathy**

An individual sometimes claims (usually in the context of a sick building lawsuit) that he or she developed toxic encephalopathy—brain damage—as a result of exposure to chemicals in the workplace. Such an occurrence is scientifically highly unlikely and probably does not occur, but it is noteworthy to understand the basis for this type of claim.

When infants at high levels, certain organic solvents may alter brain function acutely or possibly permanently. The best-known examples are lead, which general anesthetics that are used medically are toxic to brain cells of newborns and pets. For example, 100 ppm of toluene in the air in animal testing areas that are used for animal testing in the United States. These abnormalities are not present in newborns and can correlate with neurobehavioral dysfunction manifested through neurobehavioral testing. This is the classic case of the so-called psycho-organic syndrome or solvent encephalopathy.

At the lower end of the exposure scale, many studies have examined painters, printers, and others who have been occupationally exposed over long periods to moderately high levels of solvents (though far less than those sufferers have been). Many of those studies identified subtle neurobehavioral alterations identifiable through neurobehavioral testing (Hanninen et al., 1993; Olson, 1982; Orbach et al., 1987). Other studies, however, found conflicting data and did not make such identifications (Brierecker et al., 1993; Cherry et al., 1985; Colvin et al., 1993; Edging et al., 1993). Moreover, all of those studies in which changes were identified involved high exposures over prolonged working lifetimes. Generally accepted and recognized scientific evidence exists for the proposition that low-level or short-term exposures cannot produce permanent brain damage.

The reader should be cautious about extrapolations. People who claim that exposures in an office building cause such injuries base their claims primarily from three high exposures to chemicals, with a pattern of dosing quite dissimilar to that found in office building exposures. Basic understanding of toxicology tells us that such extrapolations are inappropriate.

**Reactive Airways Dysfunction Syndrome and Asthma**

RADS and asthma are disorders of the lower airways that make it difficult to move air in and out. Typically, RADS is a disorder caused by exposure to high levels of highly irritating chemicals, such as may occur after a chlorine gas release (Bernstein and Bernstein, 1988; Boulte, 1988; Brooks, Weiss, and Bern-
stein, 1985a and 1985b). Some have claimed that RADS was caused by irritant substances in indoor air that occurred following such activities as renovation or the installation of new carpeting. There is no convincing evidence that this is true, and such claims arise primarily in the context of litigation. For the most part, levels of irritants from such exposures are far too low to produce RADS.

Asthma differs from RADS in that it is related primarily to environmental allergens as opposed to irritants. Individuals with asthma may be sensitive to agents found indoors, including dust, dust mites (which live in dust), cockroaches, fungi, and mold. Asthmatics are also more sensitive to odors and irritants than nonasthmatics and may experience some discomfort if these are found in the indoor environment. What is not likely true (but has been claimed in the context of building-related lawsuits) is that a person’s asthma can be made permanently worse as a result of exposures that produce discomfort or transient exacerbation. Once the building-related exposures cease, the individual is generally no different from before (Chan-Yeung, 1995; Chan-Yeung and Mah, 1995).

**Summary**

Although health issues that relate to the office environment do exist, it seems that complaints far exceed identifiable environmental causes. This is because building-associated symptoms may or may not have anything to do with indoor air. They may be related to other environmental factors such as lighting, ergonomics, and noise; to psychosocial factors such as job satisfaction, stress, and perceptions of hazard; or to non-work-related factors such as other diseases (e.g., allergies) and home stressors.

Of course, some environmental factors can produce symptoms, such as poor ventilation, odors, infectious agents, molds and fungal spores, and some volatile chemicals. It is important to take complaints seriously and investigate appropriately. It is equally important not to overreact or spend vast sums of money for unnecessary testing or remediation.

The following eight items summarize the information presented in this chapter. Appendix II presents other information for ease of reference.

1. Health issues are more critical when they pose an imminent danger to health or life. For example, situations in commercial, nonmanufacturing settings are extremely rare. An example is a gas leak that threatens an explosion or asphyxiation. Crises of that magnitude involving biohazards have occurred only a couple of times in the history of this country; the outbreak of Legionnaires’ disease is the best-known such incident.

2. The psychological aspects of health complaints are as important as the physical aspects. In fact, they lead to more litigation and are far more expensive.

3. Building owners can minimize financial risk by being aware of the psychology of indoor health complaints. For example, they can prevent chemical odors from becoming a concern by renovating during periods when people are not in the area.

4. Most health complaints made by people in commercial and public buildings cannot be readily connected to specific environmental problems or findings unless the complaints coincide with painting or other renovations. In variability, environmental issues can be identified, but only infrequently can they be linked to health effects.

Thus, three questions must be asked:

a. Are there identifiable environmental problems that need to be corrected?
b. Are people suffering medical problems from building-related factors?
c. Does the level of psychological distress threaten the building and its occupants?

5. For those health complaints that can be related to indoor air problems, the overwhelming majority (99% or more) are minor and pose no serious threat, either short-term or permanent, to individuals. Thus, they can usually be investigated systematically and carefully without undue alarm.

6. Immediate evacuation is not usually necessary because of exposure to biological airborne carcinogens (mycotoxins). Such a conclusion of imminent health risk has no scientific basis and is inappropriate.

7. There is no epidemiological support or general acceptance of the belief that indoor environmental contaminants in commercial or public nonmanufacturing settings can cause cancer or miscarriages.

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