



# Indoor Air Facts No. 4 (revised)

## Sick Building Syndrome

### Introduction

The term "sick building syndrome" (SBS) is used to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified. The complaints may be localized in a particular room or zone, or may be widespread throughout the building. In contrast, the term "building related illness" (BRI) is used when symptoms of diagnosable illness are identified and can be attributed directly to airborne building contaminants.

A 1984 World Health Organization Committee report suggested that up to 30 percent of new and remodeled buildings worldwide may be the subject of excessive complaints related to indoor air quality (IAQ). Often this condition is temporary, but some buildings have long-term problems. Frequently, problems result when a building is operated or maintained in a manner that is inconsistent with its original design or prescribed operating procedures. Sometimes indoor air problems are a result of poor building design or occupant activities.

### Indicators of SBS include:

- Building occupants complain of symptoms associated with acute discomfort, e.g., headache; eye, nose, or throat irritation; dry cough; dry or itchy skin; dizziness and nausea; difficulty in concentrating; fatigue; and sensitivity to odors.
- The cause of the symptoms is not known.
- Most of the complainants report relief soon after leaving the building.

### Indicators of BRI include:

- Building occupants complain of symptoms such as cough; chest tightness; fever, chills; and muscle aches.
- The symptoms can be clinically defined and have clearly identifiable causes.
- Complainants may require prolonged recovery times after leaving the building.

It is important to note that complaints may result from other causes. These may include an illness contracted outside the building, acute sensitivity (e.g., allergies), job related stress or dissatisfaction, and other psychosocial factors. Nevertheless, studies show that symptoms may be caused or exacerbated by indoor air quality problems.

### Causes of Sick Building Syndrome

The following have been cited causes of or contributing factors to sick building syndrome:

**Inadequate ventilation:** In the early and mid 1900's, building ventilation standards called for approximately 15 cubic feet per minute (cfm) of outside air for each building occupant, primarily to dilute and remove body odors. As a result of the 1973 oil embargo, however, national energy conservation measures called for a reduction in the amount of outdoor air provided for ventilation to 5 cfm per occupant. In many cases these reduced outdoor air ventilation rates were found to be inadequate to maintain the health and comfort of building occupants. Inadequate ventilation, which may also occur if heating, ventilating, and air conditioning (HVAC) systems do not effectively distribute air to people in the building, is thought to be an important factor in SBS. In an effort to achieve acceptable IAQ while minimizing energy

consumption, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recently revised its ventilation standard to provide a minimum of 15 cfm of outdoor air per person (20 cfm/person in office spaces). Up to 60 cfm/person may be required in some spaces (such as smoking lounges) depending on the activities that normally occur in that space (see ASHRAE Standard 62-1989).

**Chemical contaminants from indoor sources:**

Most indoor air pollution comes from sources inside the building. For example, adhesives, carpeting, upholstery, manufactured wood products, copy machines, pesticides, and cleaning agents may emit volatile organic compounds (VOCs), including formaldehyde. Environmental tobacco smoke contributes high levels of VOCs, other toxic compounds, and respirable particulate matter. Research shows that some VOCs can cause chronic and acute health effects at high concentrations, and some are known carcinogens. Low to moderate levels of multiple VOCs may also produce acute reactions. Combustion products such as carbon monoxide, nitrogen dioxide, as well as respirable particles, can come from unvented kerosene and gas space heaters, woodstoves, fireplaces and gas stoves.

**Chemical contaminants from outdoor sources:**

The outdoor air that enters a building can be a source of indoor air pollution. For example, pollutants from motor vehicle exhausts; plumbing vents, and building exhausts (e.g., bathrooms and kitchens) can enter the building through poorly located air intake vents, windows, and other openings. In addition, combustion products can enter a building from a nearby garage.

**Biological contaminants:** Bacteria, molds, pollen, and viruses are types of biological contaminants. These contaminants may breed in stagnant water that has accumulated in ducts, humidifiers and drain pans, or where water has collected on ceiling tiles, carpeting, or insulation. Sometimes insects or bird droppings can be a source of biological contaminants. Physical symptoms related to biological contamination include cough, chest tightness, fever, chills, muscle aches, and allergic responses such as mucous membrane irritation and upper respiratory congestion. One indoor bacterium, Legionella, has caused both Legionnaire's Disease and Pontiac Fever.

These elements may act in combination, and may supplement other complaints such as inadequate temperature, humidity, or lighting. Even after a building investigation, however, the specific causes of the complaints may remain unknown.

**A Word About Radon and Asbestos...**

SBS and BRI are associated with acute or immediate health problems; radon and asbestos cause long-term diseases which occur years after exposure, and are therefore not considered to be among the causes of sick buildings. This is not to say that the latter are not serious health risks; both should be included in any comprehensive evaluation of a building's IAQ.

**Building Investigation Procedures**

The goal of a building investigation is to identify and solve indoor air quality complaints in a way that prevents them from recurring and which avoids the creation of other problems. To achieve this goal, it is necessary for the investigator(s) to discover whether a complaint is actually related to indoor air quality, identify the cause of the complaint, and determine the most appropriate corrective actions.

**An indoor air quality investigation procedure** is best characterized as a cycle of information gathering, hypothesis formation, and hypothesis testing. It generally begins with a walkthrough inspection of the problem area to provide information about the four basic factors that influence indoor air quality:

- the occupants
- the HVAC system
- possible pollutant pathways
- possible contaminant sources.

**Preparation for a walkthrough** should include documenting easily obtainable information about the history of the building and of the complaints; identifying known HVAC zones and complaint areas; notifying occupants of the upcoming investigation; and, identifying key individuals needed for information and access. The walkthrough itself entails visual inspection of critical building areas and consultation with occupants and staff.

**The initial walkthrough** should allow the investigator to develop some possible explanations for the complaint. At this point, the investigator may have sufficient information to formulate a hypothesis, test the hypothesis, and see if the problem is solved. If it is, steps should be taken to ensure that it does not recur. However, if insufficient information is obtained from the walk through to construct a hypothesis, or if initial tests fail to reveal the problem, the investigator should move on to collect additional information to allow formulation of additional hypotheses. The process of formulating hypotheses, testing them, and evaluating them continues until the problem is solved.

**Although air sampling for contaminants might seem to be the logical response** to occupant complaints, it seldom provides information about possible causes. While certain basic measurements, e.g., temperature, relative humidity, CO<sub>2</sub>, and air movement, can provide a useful "snapshot" of current building conditions, sampling for specific pollutant concentrations is often not required to solve the problem and can even be misleading. Contaminant concentration levels rarely exceed existing standards and guidelines even when occupants continue to report health complaints. Air sampling should not be undertaken until considerable information on the factors listed above has been collected, and any sampling strategy should be based on a comprehensive understanding of how the building operates and the nature of the complaints.

### **Solutions to Sick Building Syndrome**

Solutions to sick building syndrome usually include combinations of the following:

**Pollutant source removal or modification** is an effective approach to resolving an IAQ problem when sources are known and control is feasible. Examples include routine maintenance of HVAC systems, e.g., periodic cleaning or replacement of filters; replacement of water-stained ceiling tile and carpeting; institution of smoking restrictions; venting contaminant source emissions to the outdoors; storage and use of paints, adhesives, solvents, and pesticides in well ventilated areas, and use of these pollutant sources during periods of non-occupancy; and allowing time for building materials in new or remodeled areas to off-gas pollutants before occupancy. Several of these options may be exercised at one time.

**Increasing ventilation rates** and air distribution often can be a cost effective means of reducing indoor pollutant levels. HVAC systems should be designed, at a minimum, to meet ventilation standards in local building codes; however, many systems are not operated or maintained to ensure that these design ventilation rates are provided. In many buildings, IAQ can be improved by operating the HVAC system to at least its design standard, and to ASHRAE Standard 62-1989 if possible. When there are strong pollutant sources, local exhaust ventilation may be appropriate to exhaust contaminated air directly from the building. Local exhaust ventilation is particularly recommended to remove pollutants that accumulate in specific areas such as rest rooms, copy rooms, and printing facilities. (For a more detailed discussion of ventilation, read Indoor Air Facts No. 3R, Ventilation and Air Quality in Office Buildings.)

**Air cleaning** can be a useful adjunct to source control and ventilation but has certain limitations. Particle control devices such as the typical furnace filter are inexpensive but do not effectively capture small particles; high performance air filters capture the smaller, respirable particles but are relatively expensive to install and operate. Mechanical filters do not remove gaseous pollutants. Some specific gaseous pollutants may be removed by adsorbent beds, but these devices can be expensive and require frequent replacement of the adsorbent material. In sum, air cleaners can be useful, but have limited application.

**Education and communication** are important elements in both remedial and preventive indoor air quality management programs. When building occupants, management, and maintenance personnel fully communicate and understand the causes and consequences of IAQ problems, they can work more effectively together to prevent problems from occurring, or to solve them if they do.

## **Additional Information**

For more information on topics discussed in this Fact Sheet, contact your state or local health department, a non-profit agency such as your local American Lung Association, or the following:  
National Institute for Occupational Safety and Health

[www.cdc.gov/niosh/homepage.html](http://www.cdc.gov/niosh/homepage.html)

US Department of Health and Human Services  
4676 Columbia Parkway (Mail Drop R2)  
Cincinnati, Ohio 45226  
Public Relations Office

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

[www.ashrae.org/](http://www.ashrae.org/)

1791 Tullie Circle, NE,  
Atlanta, Georgia 30329

Building Owners and Managers Association  
International

[www.boma.org/](http://www.boma.org/)

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Washington, DC 20005