

Sustainable Real Estate Roundtable Briefing:

MANAGING INDOOR AIR QUALITY



Executive Summary

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Executive Summary

This Briefing on Managing Indoor Air Quality is part of SR Inc's year-round Sustainable Real Estate Roundtable (SRER) business service, which includes Member-Client Executives responsible for making nearly one and a half billion square feet of real estate more sustainable. SR Inc presents this management best practices briefing to address the expressed and growing interest of SRER Member-Clients in better management of Indoor Air Quality (IAQ) as part of their portfolio-wide sustainability strategy.

While many leading executives are working to improve the overall indoor environmental quality (IEQ) of the buildings in their portfolios, this Briefing focuses specifically on IAQ improvements, and provides information on recent developments, emerging issues, mandates, voluntary requirements, best practices, and recommendations for IAQ management best practices.

In the development of the research and recommendations presented in this briefing, SR Inc has relied on findings from leading companies as well as partnership with SRER Member-Client National Institutes of Health (NIH), which recently established the interdisciplinary Health in Buildings Roundtable (HiBR) that seeks innovative solutions to promote human health in the built environment based on scientific research and to establish metrics to measure the impact of the built environment on human health. SR Inc research into management best practices is on-going and will be updated regularly. SR Inc's recommendations are strictly vendor and solution neutral.

Key Takeaways

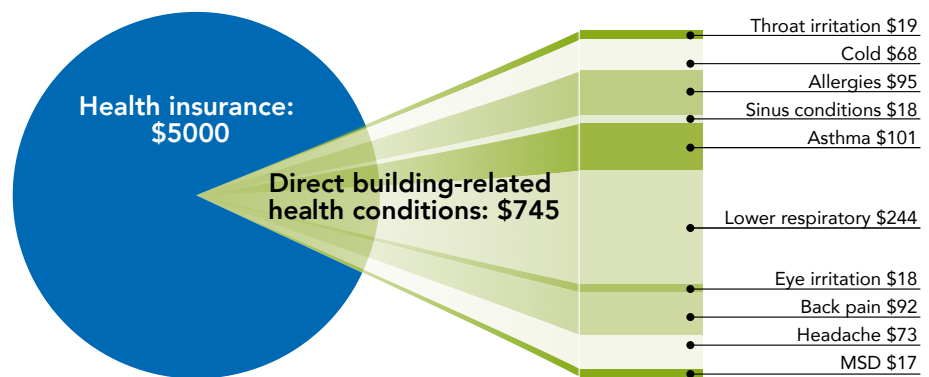
- Leading corporate users pursue IAQ management to reduce employee absenteeism and health care costs, improve productivity, reduce liability and regulatory risk, and improve brand and reputation. For owners IAQ management helps improve competitiveness and ability to attract and retain tenants, increase property values, and reduce liability and regulatory risk.
- Leading executives have found significant payback from improvements in building design, operation, and maintenance that enhance IAQ. Such improvements may often **exceed the costs by a factor of ten or more.**
- Executives implement **source reduction** as the primary strategy for improved IAQ – they establish policies for using green products in renovations and upgrades (e.g., carpets, paints, and furniture), implement green cleaning chemicals and ban smoking inside and near buildings.

- Leaders recognize the **benefits of increased ventilation** for diluting indoor contaminants and implement ventilation rates above the code requirements (cost effective approaches include demand controlled ventilation, natural ventilation, mixed-mode ventilation, enhanced filtration, and preventive maintenance).
- Leading companies **monitor key indoor air contaminants like** CO, CO₂, ozone, particulate matter, and VOCs, and go beyond the mandatory and guideline limits to improve IAQ.
- Executives are attentive to three emerging issues: (1) **LEED 2012**; (2) findings on **semi-VOCs**; and (3) expanded understanding into **indoor air chemistry**.

Introduction The Briefing begins with introduction to the issue and provides a brief background on emerging science and economic impacts of IEQ and IAQ. As illustrated below, a recent study estimated the annual direct costs of building-related illness and health conditions at \$745 per employee.¹ Significant payback can be expected from the changes in building design, operation, and maintenance that improve occupant performance because salaries and benefits greatly exceed the costs of providing and operating buildings (100 to 200 times higher than energy costs). Recent cost-benefit analyses have indicated that benefits from improved IEQ may often exceed costs by a factor of 10 or more.²

Annual direct costs of building-related illness & health conditions.

Source: Vivan Loftness, USGBC Federal Summit, 2010.



¹ Loftness, USGBC Federal Summit presentation 2010, <http://www.usgbc.org/ShowFile.aspx?DocumentID=7349>.

² Lawrence Berkeley National Laboratory, "Cost effectiveness of improving indoor environments to increase productivity", 2011, <http://www.iaqscience.lbl.gov/performance-cost.html>.

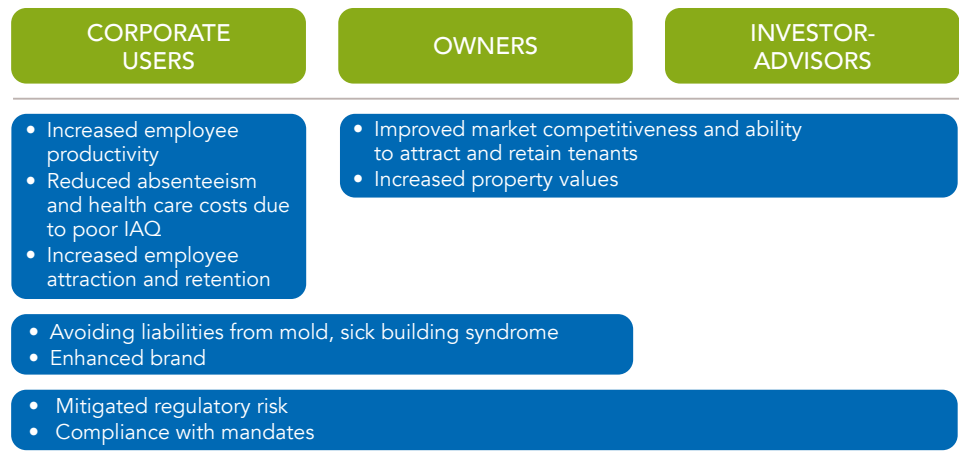
Indoor environmental quality (IEQ) includes the complete indoor environment – airborne pollutants as well as noise, light, temperature, moisture and humidity, ergonomics, etc. Real estate executives prioritize indoor air quality (IAQ), a subset of IEQ, which refers to the airborne indoor environment including pollutants such as volatile organic compounds (VOCs), carbon monoxide, carbon dioxide, mold and fungi, viruses and bacteria. IAQ can affect occupant comfort, health, and work performance. Common office complaints include dry or burning mucous membranes in the nose, eyes, and throat, sneezing, stuffy or runny nose, fatigue or lethargy, headache, dizziness, nausea, irritability and forgetfulness. Poor indoor air quality can also lead to more serious conditions.

Relevance by CRE Role

Although there is some overlap in motivation for corporate users and owners/investor-advisors, much of the motivation for IAQ is different, as illustrated below.

Relevance of deployment of IAQ strategy by CRE role.

Source: SR Inc analysis.



Occupant Health and Productivity

A vast number of studies over that past decade have demonstrated the link between IAQ and health. The research on IAQ was spurred in part by the growing number of illness reports from modern buildings. The table below summarizes the main contaminants found in an office building and their potential health effects.

Main indoor contaminants, sources, and health effects.

Source: U.S. EPA, "An Introduction to Indoor Air Quality", <http://www.epa.gov/iaq/ia-intro.html>.

Contaminants	Source(s)	Health Effects
Carbon dioxide	Result of building occupancy and inadequate ventilation.	Fatigue, sleepiness, headaches; at higher levels it is associated with dizziness, restlessness, a tingling or pins or needles feeling, difficulty breathing, sweating, tiredness, increased heart rate, and elevated blood pressure.
Carbon monoxide	Result of incomplete combustion; can be drawn from outside (e.g., underground garages).	At low concentrations, fatigue in healthy people and chest pain in people with heart disease. At higher concentrations, impaired vision and coordination, headaches, dizziness, confusion, nausea, and sometimes death.
Environmental tobacco smoke	Smoking inside or outside a building (near airflow intake).	Eye, nose, and throat irritation; headaches; lung cancer; may contribute to heart disease.
Biological contaminants	These include bacteria, viruses, fungi including mold, dust mite allergens, animal dander and pollen. Can be drawn from outside or result of higher humidity.	Allergic reactions, including hypersensitivity pneumonitis, allergic rhinitis, and some types of asthma. Molds and mildews release disease-causing toxins. Common symptoms of health problems caused by biological pollutants include sneezing, watery eyes, coughing, shortness of breath, dizziness, lethargy, fever, and digestive problems.
Volatile Organic Compounds (VOCs)	Common VOCs include formaldehyde, toluene, acetone, ethanol, hexane, benzene. Sources of VOCs in buildings are paints, carpets, furniture, cleaning chemicals, copiers and printers.	Eye, nose, and throat irritation; headaches, loss of coordination, nausea; damage to liver, kidney, and central nervous system. Some organics can cause cancer in animals; some are suspected or known to cause cancer in humans. Formaldehyde was recently declared Class A carcinogen; styrene was recently declared as suspected carcinogen.
Semi-volatile compounds (SVOCs)	These are VOCs with higher boiling point (240-260 °C to 380-400 °C) such as pesticides, phthalates, and fire retardants, among others.	Emerging science has linked this group of chemicals (known also as endocrine disruptors or EDCs) to potentially significant health effects such as developmental, reproductive, neurological, and immune system impacts as well as cancer.
Particulate matter	Particle pollution - especially fine particles with size less than 2.5 microns - contains microscopic solids or liquid droplets that are so small that they can get deep into the lungs and cause serious health problems.	Health studies have linked exposure to particulate matter to respiratory problems, reduced lung function, aggravated asthma, development of chronic bronchitis, irregular heartbeat, and nonfatal heart attacks.
Ozone	Ozone can either be drawn from outside through the ventilation system (e.g., in non-attainment areas) or be generated by copiers and printers in office environment.	Inhaling ozone is associated with various respiratory symptoms such as throat irritation, coughing, chest tightness, wheezing, and shortness of breath. In addition, ozone exposure is associated with decreased lung function and inflammation of the airways. Ozone is also highly reactive and can combine with other indoor pollutants to form even more irritating chemicals.

Emerging Issues The Briefing discusses **emerging issues, mandates and guidelines.**

There are three emerging issues that leading real estate executives are attentive to:

- **LEED 2012**, which will include much more stringent IAQ requirements such as pre- and post-occupancy IAQ sampling, maximum levels of target IAQ contaminants, emission testing of materials and furnishings and use of certified materials and furnishings.

- Findings on **semi-VOCs**, such as phthalates and flame retardants, which are persistent and difficult to measure, and have potentially significant health effects.
- Expanded understanding of **indoor air chemistry** where ozone reacts with oxidizable hydrocarbons to generate chemicals like formaldehyde, which are more irritating than originating chemicals.

Mandatory and Voluntary Requirements

A summary of recent mandates and guidelines related to IAQ is provided, including **ASHRAE 189.1-2009** standard, the **European Union Energy Performance of Buildings Directive of 2010 (2010/31/EU)**, and the **International Building Code (IBC)**. A brief overview of how IAQ is addressed in green building rating systems around the world is included as well.

Industry Case Studies

Five case studies of best practices are included to illustrate how leaders have implemented innovative strategies to improve IAQ while reducing costs. These case studies include: Steelcase Corporate Development Center, Ridgehaven Office Building, Philip Merrill Environmental Center, Royal Bank Building in Winnipeg, Canada, and Georgia Institute of Technology. The results in the case study of Georgia Tech are summarized below.

Georgia Institute of Technology

In the LEED Gold Certified Klaus Advanced Computing Center on the university campus, Georgia Tech achieved some impressive results. The Klaus Center uses 40% less energy than current energy codes through the use of more efficient lighting and natural light. The Center has preserved 50% of the site as green space and collects stormwater for irrigation.

Georgia Institute of Technology campus – Klaus Advanced Computing Center and GIT College of Management Auditorium.

Source: Charlene Bayer, Ph.D., Hygieia Sciences LLC and Georgia Institute of Technology.



There were some challenges and important lessons learned in the post-occupant study of the Georgia Tech classrooms. The ventilation system was inadequate to provide sufficient fresh air and air distribution. The system was difficult to maintain and the vehicles in parking deck beneath the building were generating high levels of CO in the ventilation system. The study also revealed that CO₂ levels decreased by an average of 400 ppm when the ventilation rate was raised from about 5 cfm/person to 15 cfm/person. While ASHRAE guidelines specify a CO₂ ceiling of 1,000 ppm, studies have found that when CO₂ is over 800 ppm there is a health impact.

Strategy Recommendation

The Briefing concludes with a section on recommended approaches for improving IAQ based on a series of six priorities for IAQ management. Detailed guidance is included for the three main steps of IAQ management – Planning, Implementation and Assessment – as illustrated below. A table with common IAQ parameters and recommended values for improving health and productivity are also provided. A list of additional resources is included for further reference.

IAQ management best practices.

Source: SR Inc research.

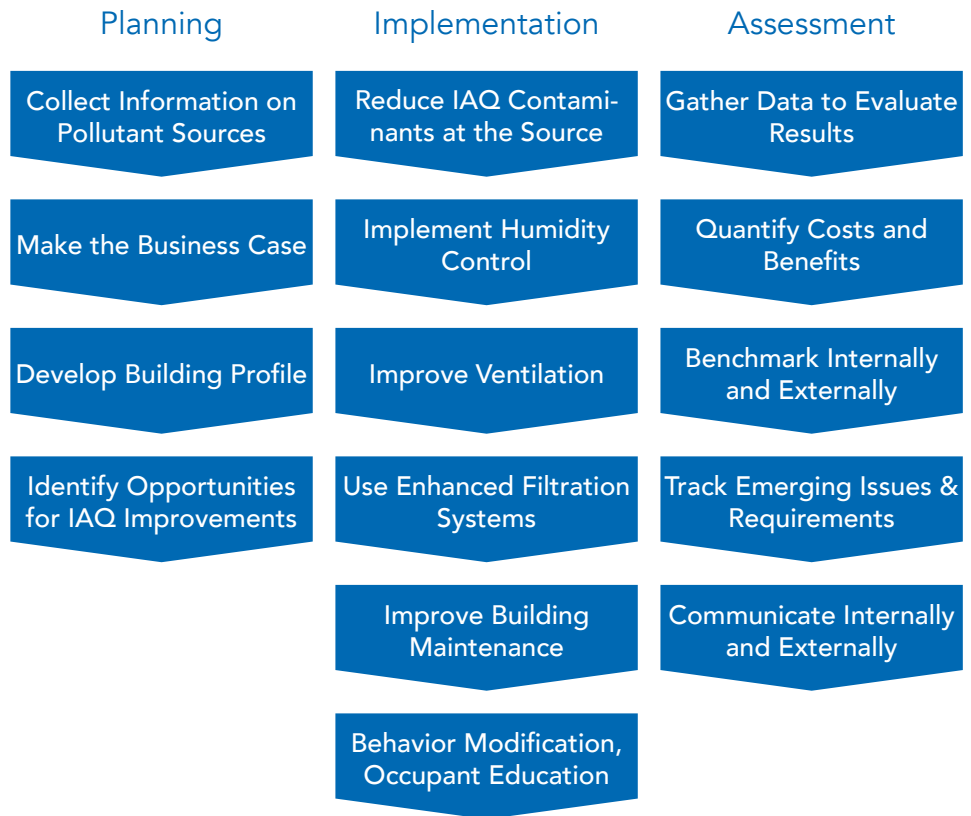


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Member-Clients should contact SR Inc with any questions or comments. Member-Clients who have IAQ best practices they wish to share with other Member-Clients are encouraged to do so for inclusion in future updates of this report.

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