

BOMA BC

QBT - Quality Building Team

**Indoor air quality - update on current issues
and trends**

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Outline

- Background on IAQ and ventilation
- In the News Now
- IAQ and worker productivity
- Other benefits of good IAQ management
- Factors that affect IAQ
- IAQ Investigations
- WorksafeBC Regulations and best practices
- Discussion of reactive versus proactive IAQ approach

INDOOR AIR QUALITY AND VENTILATION BACKGROUND

History of ventilation rates - office areas

- 19th century - state codes, 30 cfm/person
- 1914 - ASHVE, 30 cfm/person
- 1931 - New York Schools, 10-15 cfm/person
- 1946 - ASHVE Guide, 10 cfm/person
- 1967 to 1972 - ASHRAE
 - no smoking, 7.5 cfm/person
 - smoking, 40 cfm/person
- 1973 - ASHRAE 62, 25 cfm/person
- 1975 - ASHRAE 90 (**energy standard**), 5 cfm/person

Brief history of ventilation rates - office areas

- 1981 - ASHRAE 62 (adopted ASHRAE 90)
 - for non-smoking buildings, 5 cfm/person
 - for buildings permitting smoking, 20 cfm/person
- 1989 - ASHRAE 62, 20 cfm/person
- 2001 - ASHRAE 62, 20 cfm/person
- 2004 - ASHRAE 62, 15-20 cfm/person
- 2010 - based of 5 cfm/person + 0.06 cfm/ft² (effectively 17 cfm/person) - occupant density lowered to 5 people/1,000 ft²

IAQ Health Outcomes

“Recent studies have shown that costs of poor indoor environment for the employer, building owner and society as a whole are often considerably higher than the cost of the energy used in the same building”

“An energy declaration without a declaration to the indoor environment makes no sense”

British Standards EN15251:2007 - Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics.

IN THE NEWS NOW

Legionella and IAQ

- Legionella pneumophila is a bacteria that can be found in water sources in buildings (cooling towers, hot water tanks, humidifiers, spas/hot tubes, water distribution systems (showers), water features, etc.)
- Exposure to the water droplets containing this bacteria can lead to Legionnaires Disease.
- Very big concern in North America right now (many law suits in the United States)
- Many outbreaks in different cities both in Canada and United States
- There is a new book from the AIHA on Legionella - (Recognition, Evaluation, and Control of *Legionella* in Building Water Systems, May 2015) - recommends regular testing of water sources.

Legionella and IAQ

- **July and August 2015!!**
- New York City - more than 100 cases reported of Legionnaires Disease and 12 deaths (up to August 20, 2015)
- Isolated to the South Bronx area and suspected to be caused by cooling tower systems of 5 different buildings ... not affecting the IAQ but passersby outdoors
- as of August 4, the water of these buildings was treated and was tested to show

Radon

- BOMA-BC has been approached by Radon Aware (<http://www.radonaware.ca>) about radon.
- Radon is a NORM - naturally occurring radioactive material
- Radon is a radioactive gas produced by the decay of radium isotopes in both the uranium and thorium radioactive decay series.
- As it is a gas, radon can be carried away from its origin by air or water flows, and released into workplace air.

Radon

- For years, the guideline was 800 Bq/m³
- Then it was lowered to 200 Bq/m³
- Health Canada
 - Less than 200 Bq/m³ - no action required
 - 200-600 Bq/m³ - action in less than 2 years
 - > 600 Bq/m³ - action in less than 1 year

Radon - SIAQ experiences

- Lower levels of commercial real estate can be susceptible to elevated radon
- This is particularly true in poorly ventilated spaces on lower levels
- Concrete appears to be a source itself
- More and more commercial sites asking for radon testing as a due diligence tool

IAQ AND WORKER PRODUCTIVITY

IAQ and Worker Productivity

- Fisk, et al – increased ventilation rates in office buildings = faster work rates
- Federspeil, et al
 - high temperature = lower work rate
 - high occupant density = lower work rate
- REHVA (European ASHRAE)
 - Improving IAQ increases productivity by 4%
 - This correlated to a net benefit of 150 Euros/month/person

IAQ and Worker Productivity

- Abdou, et al
 - Improved environment decreases complaints and absenteeism
 - Estimated there could be **20% increase** in productivity by improving IAQ
- Olesen – **5-10% increase** in productivity with good IAQ

IAQ and Worker Productivity - Questions

- What do the results of all of these studies conclude?
- What are the benefits to managing IAQ and ensuring there is good IAQ?
- Does reducing energy costs actually save money?

IAQ and Worker Productivity - Facts

- Workers are more productive when there is good IAQ!!
- Maintaining exceptional IAQ has actually been calculated to have a positive financial benefit to employers/tenants

OTHER BENEFITS OF GOOD IAQ MANAGEMENT

Benefits of Good IAQ - for building owner/manager/tenant

- Risk Management
- Reduced insurance and liability costs Decreased absenteeism
- Improved mood of occupants/workers
- Improved relationship between workers/employer and employers/building management
- Useful in lease negotiations

FACTORS THAT AFFECT IAQ

Main factors affect IAQ

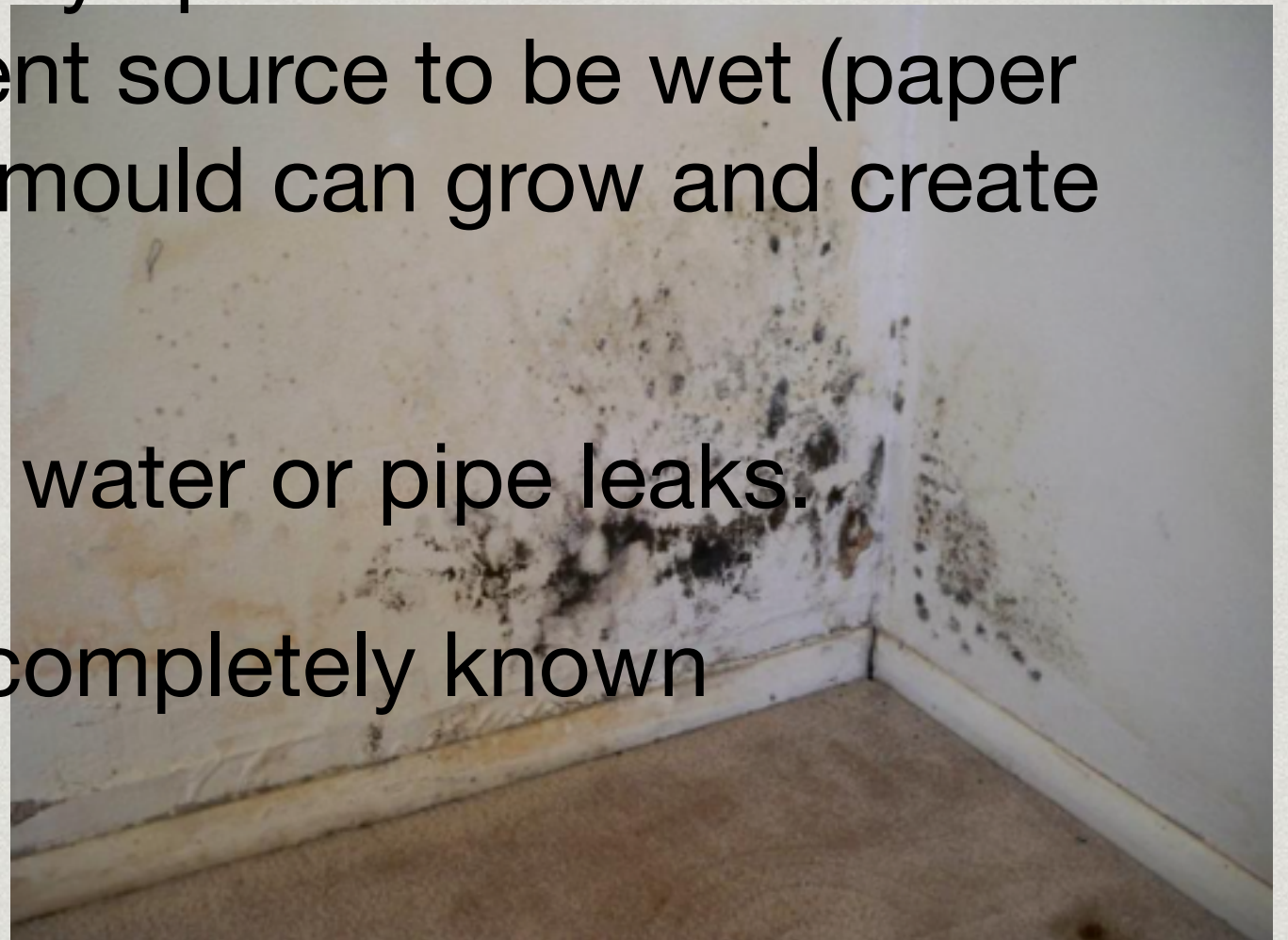
- Ventilation system design, operation and maintenance
- Outdoor air pollution
- Moisture - creates mould issues
- Building materials and furniture off-gassing
- Construction contaminants
- Plumbing and mechanical systems

Other factors affecting IAQ

- Indoor activities (printing, parking areas, adjacent tenant activities)
- Occupants (fragrances, body odours)
- Overall building performance and systems (pressurization, infiltration, stairwells)
- Water systems - cooling towers, water features, etc. (Legionella)
- Sub-surface soil contamination

Moisture and mould

1. Very big issue in Canada and the United States
2. Mould spores are always present in the air but need a suitable nutrient source to be wet (paper faced drywall) - then mould can grow and create IAQ issues.
3. Moisture not just rain water or pipe leaks.
4. Health effects? Not completely known



Building material and furniture off-gassing

1. Volatile organic compounds (VOCs) - for IAQ, usually assessed as total VOCs (TVOCs).
 1. from flooring, paints, adhesives, cabinets, furniture
2. Formaldehyde - from manufactured wood products
3. 4-phenyl cyclohexene (4-PCH) from Styrene Butadiene (SB) latex backed carpet

Construction Contaminants

1. Particulate

2. VOCs

3. Asbestos in old building being renovated



Plumbing and Mechanical Systems

1. Dry floor drains - odours
2. Faulty bathroom exhaust fans
3. Cracked pipes - no water leaks but odours seep out
4. Plumbing vent stacks - typical odours, waterless urinal odours



Other factors



1. Tenants - they block vents, introduce materials with odour, permit too many people in a small space, install server rooms which create too much heat, adjust thermostats
2. New fibreglass faced gypsum/drywall products
3. Rodent infestation - droppings, deceased rodents
4. Allergens - from rodents and PETS!
5. Poor maintenance of building and mechanical systems



THE IAQ INVESTIGATION PROCESS AND PRIMARY PARAMETERS OF AN IAQ ASSESSMENT

Typical Process of an IAQ Investigation

1. Complaint is logged
2. Complainant(s) interviewed
3. HVAC inspected/assessed
4. Testing/sampling
5. Data interpretation/reporting
6. Corrective action if necessary
7. Document corrective action – close the loop.



Parameters of an IAQ Investigation

Carbon dioxide (CO₂)

Exhaled by occupants

Primary parameter for IAQ testing

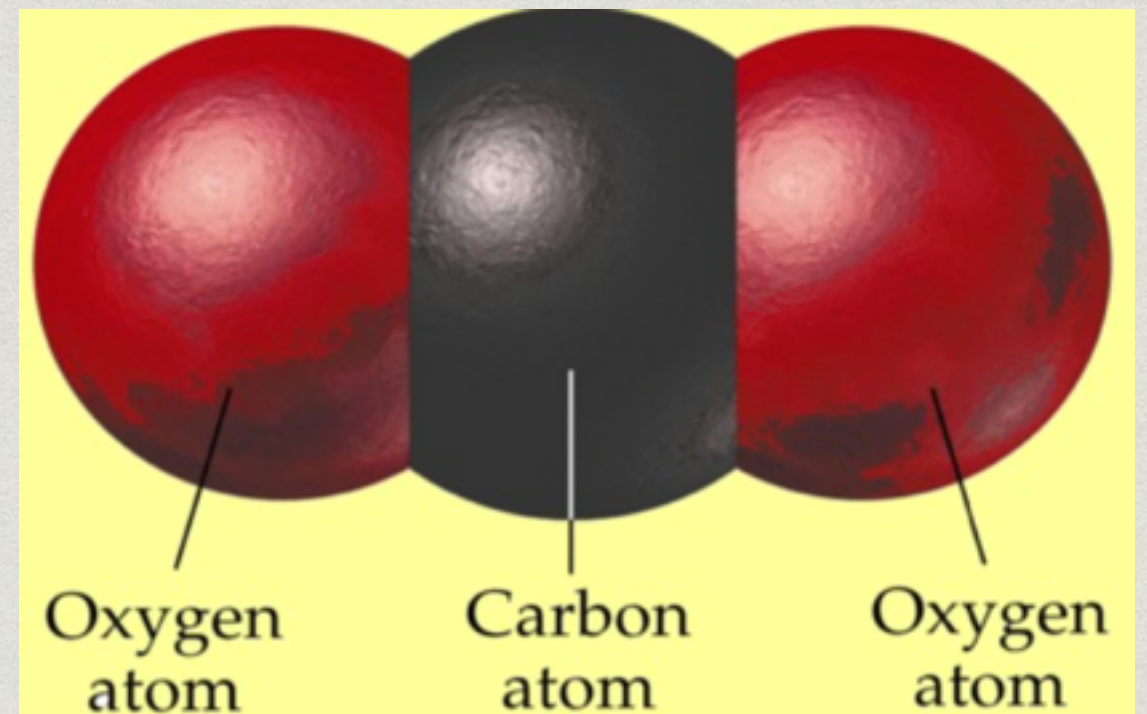
Not considered a 'toxic' contaminant

Considered an indicator of ventilation system effectiveness

600 ppm inside = 42 cfm/person

800 ppm inside – 24 cfm/person

1,000 ppm inside = 16 cfm/person



(Based on 350 ppm outdoor concentration and using ASHRAE equation)

Parameters of an IAQ Investigation

Carbon monoxide

- Combustion by-product
- Colourless, odourless
- Heat exchangers, parkades, boiler exhaust, forklifts, etc.
- Vehicles near air intake
- Stack effect from parkade is possible



Parameters of an IAQ Investigation

Temperature and Relative Humidity (RH)

- Comfort parameters
- Elevated temperature can lead to complaints of 'poor air quality'
- Low RH can lead to complaints
- High RH can lead to other issues (mould, dust mites, etc.)

Parameters of an IAQ Investigation

Particulate

- Respirable Particulate (RSP) or PM_{10} - $10\ \mu m$
- Fine Particulate $PM_{2.5}$ - $2.5\ \mu m$
- Ultra fine particulate - less than $0.1\ \mu m$
- Assesses level of filtration afforded by ventilation system - compare indoor to outdoor
- Determines if there are indoor sources of particulate (construction) or if outdoor particulate affecting IAQ
- Assesses general cleanliness of space

Parameters of an IAQ Investigation

Volatile organic compounds (VOCs)

- New construction, new building materials, dry cleaners, shoe repair, nail salons, hair salons, leather stores, printing operations.
- Measures potential off-gassing of building materials and furniture
- We can measure individual VOCs but total VOCs (TVOCs) are generally used for assessing IAQ

Parameters of an IAQ Investigation

Other parameters

- Ozone
- Formaldehyde
- **Mould**
- Bacteria
- Asbestos
- 4-PCH
- Environmental tobacco smoke
- Allergens (pollen, dust mites, pet dander, pests)
- NEW! E-cigarette contaminants

03



Parameters of an IAQ Investigation - HVAC Inspections



Fully closed outdoor air dampers



**Filters installed
backwards**

Parameters of an IAQ Investigation - HVAC Inspections



**Birds
nesting
under
intake**



Parameters of an IAQ Investigation - HVAC Inspections



**2-3 month old building
complaints of stuffiness
and dust**



REGULATIONS ASSOCIATED WITH INDOOR AIR QUALITY

AND BEST PRACTICES

WorksafeBC Regulation

Section 4.70 to 4.80 of the Occupational Health and Safety Regulation – notable sections.

4.74 Distribution

Outdoor air must be effectively distributed throughout the workplace.

4.75 Balancing

The ventilation system must be balanced to

- (a) ensure that each space within the building receives an adequate allotment of outdoor air, and
- (b) accommodate the actual or the normally anticipated occupancy of each space.

4.76 Ventilation openings

- (1) A ventilation system must not be obstructed by material or equipment placed in front of the ventilation air intakes or discharge points.
- (2) Outdoor air intakes must be located so that outdoor air entering the ventilation system does not contain any contaminant in a concentration greater than normal outdoor ambient air in that locality.

WorksafeBC Regulation

4.77 Discharged air

A ventilation system that discharges air from the work area must be designed to minimize the likelihood of exposing any worker at a workplace, including an adjacent workplace

- (a) to an air contaminant in a concentration which exceeds either 10% of its applicable exposure limit in Part 5 (Chemical Agents and Biological Agents), or an acceptable ambient air quality standard established by an authority having jurisdiction over environmental air standards, whichever is greater, and
- (b) where practicable, to an objectionable odour.

WorksafeBC Regulation

4.79 Investigation

- (1) The employer must ensure that the indoor air quality is **investigated** when
 - (a) complaints are reported,
 - (b) occupancy in the space changes substantially, or
 - (c) renovations involving significant changes to the ventilation system occur.
- (2) An air quality investigation must include
 - (a) assessment of the ventilation rate, unless the **indoor carbon dioxide level is less than 650 ppm above ambient outdoor levels**,
 - (b) inspection of the ventilation system as required in section 4.78(2),
 - (c) sampling for airborne contaminants suspected to be present in concentrations associated with the reported complaints, and
 - (d) a record of the complaint, the findings of the investigation, and any actions taken.

Best Practices - Presently in Canada

- Develop written IAQ management plan
 - regular HVAC filter changes and system maintenance
 - effective delivery of outdoor air
 - prompt response to complaints
 - annual proactive IAQ testing by outside party (consultant)
- Develop written construction IAQ management plan
 - ensures construction work in building does not affect other tenants
- Develop written legionella plan
 - ensure bacteria cannot grow in water sources
 - regularly test water sources (tanks, water features, cooling tower)

Best Practices - Presently in Canada

- LEED Certification - New Construction
 - IAQ testing regularly being conducted
- LEED Certification - Existing Buildings
 - IAQ Audits being conducted for existing buildings
- Annual Proactive IAQ Program and testing
 - thorough testing every 6 months to 1 year
 - provide results to tenants
 - use long term results in corporate sustainable reporting

PROACTIVE IAQ TESTING DATA

WHAT CAN YOU DO WITH THE INFORMATION?

Proactive IAQ testing data - what have we done in Canada?

- After testing 300+ buildings over several years across Canada, an extensive database of IAQ (and outdoor) data was developed
- Corporate sustainable reporting!!
- Carbon dioxide
 - Buildings with elevated carbon dioxide need more outdoor air (recommendations were made in the reports)
 - Buildings with very low carbon dioxide - Sterling IAQ developed list for clients to suggest they save energy by reducing outdoor air ventilation rates (changes to operation of ventilation system)

Proactive IAQ testing data - what have we done in Canada?

- Particulate
 - with each test period - have shown that indoor PM₁₀ levels usually below outdoor PM₁₀ levels
 - indoor PM₁₀ - average 10 µg/m³
 - outdoor PM₁₀ - average 19 µg/m³
- For a real estate portfolio, Sterling IAQ calculated the total particulate removed from the outdoor air of urban centres ... then correlated that to the number of vehicles removed from the road
 - 22 million ft² of commercial office space
 - approximately 4,300 light duty passenger vehicles theoretically removed from the roads

IAQ AND OUTDOOR AIR QUALITY - A CASE STUDY

CANADA VS CHINA

Canada compared to China - a case study

- Outdoor air pollution is a concern in China
 - PM_{2.5} in 2014 in Beijing - 85.9 µg/m³ average
 - Visible smog is a regular problem
- In July 2015 in British Columbia, forest fires affected the outdoor air quality in Vancouver
 - City was affected by visible smog and elevated outdoor PM_{2.5} and PM₁₀

Canada versus China - a case study



Canada versus China - a case study

- July 7, 2015 testing of downtown Vancouver office building - visible smog/pollution on this day
- Outdoor PM₁₀ measured 48.5 µg/m³ (normal Vancouver outdoor PM₁₀ levels are 18 µg/m³)
- Indoor PM₁₀ concentrations ranged from 4 to 22 µg/m³ with an average of 6 µg/m³ (consistent with previous test periods - with no forest fires)
- Carbon dioxide in 2015 was similar to previous test years
- **What does this conclude?**

FINAL THOUGHTS

Final Thoughts on IAQ

- Legionella becoming a larger issue
- Radon also gaining attention
- Workers satisfied with their IAQ are MORE productive
- Proactively addressing IAQ has become the norm and has reduced the need for reactive IAQ investigations.
- Mould still a big issue because we continue to have water issues

THANK YOU.

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