

# Doing Something about Indoor Air Quality

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#### **Outline:**

- introductions
- general basics (SBS)
- thermal comfort
- ventilation
- contaminants
- investigation techniques
- personal health factors
- stress
- prevention resources



### **IAQ starts with symptoms:**

- Increased prevalence of non-specific, common symptoms:
  - headache
  - fatigue
  - irritated eyes, nose, throat and/or skin
  - symptoms clear when away from building
- commonly called "Sick Building Syndrome" (SBS)
- but more accurately referred to as "building related non-specific symptoms" (BRS) or specifically (e.g. mucous membrane irritation)



#### Recognized Building Related Diagnoses:

#### **Building Related Illnesses (BRI):**

#### infection:

- Legionnaire's Disease, Pontiac Fever
- Aspergillosis (immune-compromised)
- SARS, TB, rubeolla
- colds & flu

#### allergic reactions:

• asthma, rhinitis, eye problems

#### toxic reactions:

• CO, mycotoxins, endotoxin, chemical spills, cancer (asbestos)



## How Common are IAQ Problems?





# Other Causes of "SBS" Symptoms:

- Ergonomics
  - lighting
  - noise
  - workstation design
- workplace or non-occupational stress
- personal health factors





### **Difficulties pleasing everyone**



## Legislation & Standards:

- Ontario Building Code refers to:
  - ASHRAE 62.1-2013 Ventilation for Acceptable IAQ
  - ASHRAE 55-2013 Thermal Environmental Conditions for Human Occupancy
- Ontario Ministry of Labour uses the "General Duty" Clause

(OH&S Act section 25(2)(h)) and, cites ASHRAE 62 in orders

- Federal standard:
  - Canada Labour Code, Part II
  - Permanent Structures Regulation, Division III: HVAC systems

http://laws.justice.gc.ca/eng/SOR-86-304/page-1.html#anchorbo-ga:L\_II-gb:L\_III



# Futility of the compliance approach:

- measuring for IAQ investigation purposes is different than traditional industrial hygiene personal exposure measurements
- usually area measurements
- evaluating the performance of ventilation systems/building maintenance/housekeeping
- trying to identify sources/causes
- criteria are usually tiered (no prblm; possible prblm; probable prblm, definite prblm)





### **Context: IAQ standards**

ASHRAE 62.1-2013 "Ventilation for Acceptable Indoor Air Quality" states:

 "acceptable indoor air quality: air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction."

ASHRAE Standard 55-2013 "<u>Thermal</u> <u>Environmental Conditions for Human</u> <u>Occupancy</u>" specifies:

"The operative temperature and humidity ... are for 80% occupant acceptability."





### ASHRAE 55-2013:

- Sets out thermal comfort requirements for 80% thermal occupant acceptability
- Prescribes range of temperature/ humidity levels (humidity levels to be removed)
  - summer: 24-27°C (@50% RH)
  - winter: 21-25°C (@30% RH)
- Prescribes maximum temperature fluctuation rate (2.2°C/hr)

ANSI/ASHRAE Standard 55-2013 (Supersedes ANSI/ASHRAE Standard 55-2010) Includes ANSI/ASHRAE addenda listed in Appendix M

#### Thermal Environmental Conditions for Human Occupancy

See Appendix M for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, and the American National Standards Institute.

This strated is under controlous mantenines by a Standing Standard Project Committee (SPC) for which the Standards Committee has established a documenter program for regispre publication of addecide and or revision, reluting procedures for thinky, documented, conserve action on requests for change to any part of the standard. The change submittal form, instructions, and documented, conserve action on requests for change to any part of the standard. The change submittal form, instructions, and documented, conserve actions on requests for change to any part of the standard. The change submittal form, instructions, and of Standards. The taster dottion of an ASHRAE Standard may the purchased from the ASHRAE Web site (www.shara.org) or to form of the Hanger of Standards. The taster dottion of an ASHRAE Standard may the purchased from the ASHRAE Web site (www.shara.org) or to form ASHRAE (customers, 1974). Tails Circle, N.E., Adatar, G.A. 10327-3025. E-milt: ordensity/instruction.org. Face (FR-S)-S1219. Telephone: 694-686-4960 (www.shara.org) permittions.

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STANDARD







### thermal comfort calculator

#### Comfort Calculator (ISO7730-1993)





#### http://www.healthyheating.com/solutions.htm

### thermal comfort calculator

#### Comfort Calculator (ISO7730-1993)





http://www.healthyheating.com/solutions.htm









### temperature: Dose - Response



### **Relative Humidity:**

- a measure of the capacity of the air to evaporate water
- a percentage of how much water is in the air divided by how much it can hold
- not a direct measure of how much water is in the air (dew point is a better measure of that) – accuracy usually ±3-5%
- too high (>65%): biological growth
- too low (<30%): dry mucous membranes, static electricity



#### **Relative Humidity:**



The ratio between the actual amount of water vapor held in the atmosphere compared to the amount required for saturation. It is influenced by temperature.

# Which environment has higher water vapor content?





...therefore the desert air has more water in it!

dew point 5°C

### Health Risks vs. RH

Decrease in Bar Width Optimum Indicates Decrease in Effect Zone										
Bacteria		L	L						<u> </u>	1
Viruses										
Fungi										
Mites										
Respiratory Infections*										
Allergic Rhinitis and Asthma										
Chemical Interactions										1
Ozone Production										
Insufficient Data Above 10 20 30 40 50 60 70 80 90 50 per cent R.H. Per Cent Relative Humidity										
by Sterling et al in ASHRAE Transactions 1985 Vol. 91 Part 1										

#### **Office (Mar 26/01)**



#### time (in minutes)







Ventilation for Acceptable

Indoor Air Ouality

#### ASHRAE 62.1-2013:

- A special (see word as the 30-000 for the Contex, see ADMA for all the curve, set do not extrational and the context of the adma for the set of the context of the context of the the set of the context of the contex
- Sets out design and operational requirements
- two procedures for prescribing adequate air quality:
  - ventilation rate prescribes minimum quantity of outdoor air supply per occupant (e.g. 17 cfm/person in an office environment, 15 cfm/person in classroom (for ages 5-8); CO<sub>2</sub> as a marker of dilution rates)
  - IAQ procedure prescribes minimum quality of supply air (measure contaminants; CO<sub>2</sub> as a marker for bio-effluents)



#### go look on the roof ...



#### make sure you look inside



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#### never know what you'll find ...





# Ventilation System (outdoor air supply):

- carbon dioxide as an evaluation criteria (measures air turnover rates)
- standards (surrogate, <u>not</u> exposure)
  - **ASHRAE** #62-2010
    - 17 cfm/person (equivalent to 900 ppm CO<sub>2</sub> if outside CO<sub>2</sub> is 380 ppm; 15 cfm/person equivalent to 1000 ppm CO<sub>2</sub> or CO<sub>2</sub> level no more than 700 ppm above background)
  - Ministry of Labour
    - background (outside air)
    - no problem
    - possible problem
    - more outdoor air needed
    - TWAEV

400-500 ppm 650 ppm 850 ppm 1100 ppm 5000 ppm



# Measuring air flow:







#### **Detector tubes:**









# CO<sub>2</sub> datalogging









#### AHU #3 System (Jan 26-27/01)




#### March 6/00 (portable)



#### Background $CO_2$ Measurements







#### Polar icecap measurements

#### **EPICA DOME C : drilling**

#### 1999/2000 : casing 112m

2000/2001 . 1459m

2001/2002 : 2864m 2002/2003 : 3200m 2004/2005 : 3270m

http://www.esf.org/index.php?id=855

DC1 1996/1997 : casing 108m 1997/1998 : 364m 1998/1999 : 781m

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http://news.mongabay.com/2005/1124-climate.html



#### Types of Air Quality Factors, Contaminants & Toxins



WELL UNDERSTOOD

PARTIALLY UNDERSTOOD

LITTLE UNDERSTOOD



http://esc.syrres.com/sraupstateny/downloads/symposium%20presentations/vasselli.ppt

## Contaminants (odours):



- odour reactions linked to primitive "fight or flight" reaction
- odours also interpreted in terms of past experience (associations)
- distinguish between toxic, irritation and association reactions

(e.g. nose can detect 2200 molecules of skunk; n-butyl mercaptan odour threshold: 0.0001 ppm)



# Contaminants (VOC's):

#### Volatile Organic Compounds (VOC's)

- VOC's can aggravate allergy/asthma and upper respiratory infections
- exposure standards
  - IAQ (Mölhave & EPA)
    - no problem
    - possible problem
    - probable problem

– TLV's 250-1000 mg/m<sup>3</sup>

• problem

<0.2 mg/m<sup>3</sup> 0.2-3.0 mg/m<sup>3</sup> 3.0-25 mg/m<sup>3</sup> >25 mg/m<sup>3</sup>



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Number of days after area recarpeted

**TVOC** (total volatile organic compounds) concentrations in an office space with background concentrations subtracted, immediately following recarpeting of the area (graph courtesy of Dr. G. Kerr, InAir Environmental Ltd.)

http://www.nrc-cnrc.gc.ca/eng/ibp/irc/ctus/ctus-n3.html

### Contaminants (carbon monoxide):

 usually an indicator of vehicle exhaust infiltration or other combustion source

- standards (surrogate & exposure)
  - TWAEV:
  - STEL:
  - environmental:
  - Health Canada
  - IAQ practice:

25 ppm (8-hour ave)
100 ppm (15 min)
9 ppm (24-hour ave)
>5 ppm (spot: infiltration)
>2 ppm (spot: infiltration)



# **Carbon Monoxide Example:**



# Contaminants (ozone):

Sources: photocopiers, laser printers, fax machines

Health effects: ozone is very reactive (1/2 life of 15 minutes); ages lung tissue, aggravates breathing problems, can cause asthma; heightens allergic response

Measurement: very difficult to measure but easy to detect by odour (fresh air smell; if detected probably over exposure guideline of 0.05-0.1 ppm)

**Control:** equipment often has a charcoal filter to absorb ozone (often not changed frequently enough – if odour, change filter); local exhaust directly to machine may be necessary for high volume usage particularly in small room



## Contaminants (dust):



"There is no recognized threshold of health effects for outdoor  $PM_{2.5}$  regardless of where exposure occurs (i.e., indoors or outdoors), and there is evidence that adverse health effects occur at current levels of exposure." (Health Canada 2012 http://www.hc-sc.gc.ca/ewh-semt/pubs/air/particul-eng.php)

- exposure standards
  - IAQ (LEED, EPA, OHCOW, Health Canada)
    - background\*
    - possible problem
    - probable problem
    - problem
  - TWAEV, TLV

<0.010 mg/m<sup>3</sup> 0.01-0.02 mg/m<sup>3</sup> 0.02-0.05 mg/m<sup>3</sup> >0.05 mg/m<sup>3</sup> 3 mg/m<sup>3</sup>

– Xerox 0.4 mg/m<sup>3</sup> (avoid alveolar accumulation)



# Ultra-fine Particulate (UFP):



- ultra-fine particulate (<1 microns in diameter) may be the cause of SBS symptoms if such particles are present
- there are no legislated standards for ultrafine particulate in Ontario, however, there are anecdotal reports of significant success in resolving SBS symptoms by identifying and eliminating sources of ultra-fine particulate
- research has shown that an increase of 7000-14,000 pc/cc of traffic related (combustion product) UFP's causes measurable reactions in the lungs



# Outdoor air quality:

- Environment Canada has air monitoring stations throughout the country which measure (on an hourly basis):
  - ozone
  - particulate matter smaller than 2.5  $\mu$ m (PM<sub>2.5</sub>)
  - nitrogen oxides (NO<sub>2</sub>, NO)
  - sometimes: sulphur dioxide, carbon monoxide
- The AQI (Air Quality Index) is a measure of the quality of the air based on a mathematical manipulation of the measurements using the following scale:







#### London: April 19, 2008

Air Quality for London						
Date	Time	AQI	Category	Cause		
Note: AQI readings on this web page are based on automatically polled data and have not undergone final verification.						
19-Apr-08	11:00 PM EDT	40		Fine Particulate Matter (PM <sub>2,5</sub> )		
19-Apr-08	10:00 PM EDT	36		Fine Particulate Matter (PM <sub>2.5</sub> )		
19-Apr-08	9:00 PM EDT	40		Ozone (O <sub>3</sub> )		
19-Apr-08	8:00 PM EDT	44		Ozone (O <sub>3</sub> )		
19-Apr-08	7:00 PM EDT	50		Ozone (O <sub>3</sub> )		
19-Apr-08	6:00 PM EDT	50		Ozone (O <sub>3</sub> )		
19-Apr-08	5:00 PM EDT	49		Ozone (O <sub>3</sub> )		
19-Apr-08	4:00 PM EDT	48		Ozone (O <sub>3</sub> )		
19-Apr-08	3:00 PM EDT	45		Ozone (O <sub>3</sub> )		
19-Apr-08	2:00 PM EDT	44		Ozone (O <sub>3</sub> )		
19-Apr-08	1:00 PM EDT	40		Ozone (O <sub>3</sub> )		
19-Apr-08	12:00 PM EDT	38		Ozone (O <sub>3</sub> )		
19-Apr-08	11:00 AM EDT	35		Fine Particulate Matter (PM <sub>2.5</sub> )		
19-Apr-08	10:00 AM EDT	37		Fine Particulate Matter (PM <sub>2.5</sub> )		



 $\underline{http://www.airqualityontario.com/reports/aqisearch.cfm?StationID=15025\&this\_date=19-Apr-08\&startmonth=24hourillipsilon_{10}}{brainsplaystartmonth} = 15025\&this\_date=19-Apr-08\&startmonth=24hourillipsilon_{10}}{brainsplaystartmonth} = 15025\&this\_date=19-Apr-08\&startmonth=24hourillipsilon_{10}}{brainsplaystartmonth} = 15025\&this\_date=19-Apr-08\&startmonth=24hourillipsilon_{10}}{brainsplaystartmonth} = 15025\&this\_date=19-Apr-08\&startmonth=24hourillipsilon_{10}}{brainsplaystartmonth} = 15025\&this\_date=19-Apr-08\&startmonth$ 

#### **Outdoor & indoor particulate**





# **Contaminants (biological):**

- health responses to moulds:
  - infection (rare, only in susceptible persons)
  - allergic (immune response)
  - toxic (high exposures)
  - irritant (common)
  - combination (e.g. allergic & irritant)
- demolition workers with bleeding lungs



# **Contaminants (biological):**

- TYPES OF MOULD (interpretation): *Cladosporium, Alternaria, Eppicoccum* (CAE) common species: expected but less than outdoors *Penicillium, Aspergillus, Eurotium* (PAE) look for damp amplification sources *Stachybotrys*: indicates chronic damp conditions
- experienced walk-through:
  - visible mould
  - odours (musty, stale)
  - history of water leaks, condensation
  - occupants with symptoms



# more water problems:







# mould?

#### Sampling air for bio-aerosols:









# growing cultures







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### Interpreting Mould Sampling Results:

- absolute numbers don't mean much (numbers interpreted relatively)
- "zeros" don't really mean no mould
- genus and species can be important
- no absolute numbers to compare to
- visible evidence of mould infestations over-rides "negative" results



# **Contaminants (biological):**

- studies show that the <u>surface area</u> visibly colonized with mould is the **best exposure** measure to predict health outcomes (better than air sampling results)
- early changes in children's immune system can be detected in houses with 2-4 m<sup>2</sup> of contaminated surfaces (1-5% of total surface area) (Arch Environ Health <u>53</u>:190-195 (1998))



# **Contaminants (Allergens):**

**Sources:** pollen from outside (in through filters), insect debris, cat allergen brought in by pet owners, fungi (from outside and/or inside), bacteria

Health effects: hayfever, rhinitis, sinusitis, dermatitis, asthma (co-presence of irritants can aggravate inflamed tissue)

Measurement: can be done but not done commonly, very difficult to decide what to measure for (time pattern of symptoms and medication usage adequate indicator of building-relatedness)

**Control:** improve housekeeping, HEPA vacuum, improve filtering, promptly address water leaks, dry building materials within 48 hrs or replace, reduce VOC load, scent-free policy



## Finding damp building materials

- Meters can measure the moisture content of building materials
- For drywall the moisture content should be less than 0.7%.
- For wood, the moisture content should be <17%.
- Moisture levels above these thresholds will begin to support mould growth.





### Lighting: Visual Acuity Factors

- Task
  - Size
  - Brightness
  - Contrast
  - Exposure time
  - Nature of object
  - Degree of accuracy
  - Moving or stationary
  - Peripheral patterns
- Lighting Condition
  - Illumination level
  - Disability glare
  - Discomfort glare
  - Luminance ratios
  - Brightness patterns

- Observer
  - Health and age
  - Adaptation level
  - Fatigue level
  - Subjective impressions
  - Psychological reactions

From Stein and Reynolds, *Mechanical and Electrical Equipment for Buildings 9<sup>th</sup> edition*, p.1067





Design G	uidelines for HVAC-
related B	ackground Sound
2011 ASHRAE Hand HVAC Applica	lbook – ations (SI) Table 1 page 48.3
open-plan offices:	Room Criteria (RC): RC ≤40 (equivalent to 45 dBA)
private offices:	Room Criteria (RC): RC ≤30 (equivalent to 35 dBA)
	Quality-Assessment Index (QAI): QAI ≤5 dB (N)
N = neutral (balance LF = rumble (low from LFV <sub>B</sub> = rumble (low LFV <sub>A</sub> = rumble (low MF = roar (mid-free HE = biss (bigb-free	ed sound spectrum) equency dominant) / frequency with moderately perceptible vibration) / frequency with clearly perceptible vibration) quency dominant)

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## **Cost-effective Open Plan Environments (COPE project)**

- The National Research Council Canada (NRCC) has developed standards for open plan office environments (COPE)
- For noise the COPE recommendations are:
  - Ensure that all noise sources (e.g., ventilation systems, office equipment and water coolers) do not exceed 40 dBA.
- The COPE research finding identified the optimum noise level (background & foreground) for open plan offices was determined to be between 42-48 dBA

Environmental Satisfaction in Open-Plan Environments: 6. Satisfaction Algorithms for Software By Newsham, G.R.; Veitch, J.A.; Charles, K.E.; Marquardt, C.J.G.; Geerts, J.; Sander, D.M. 2003



# **Tonal analysis:**

- Using the ISO:1996 2007 <u>Acoustics Description</u> <u>and Measurement of Environmental Noise</u>, we can calculate whether there was any tonal noise present in the background noise spectrum
- The standard defines a tonal noise as a 1/3<sup>rd</sup> octave measurement that is at least:
  - 5 dB higher than the average of its neighbouring octaves (for >500 Hz),
  - greater than 8 dB for 125-500 Hz octaves and
  - greater than **15 dB** for octaves <125 Hz</p>
- Tones are an annoying aspect of sound



# Low Frequency "noise"

- Frequencies below what are considered normal audio ranges have an impact on hearing loss and the human body
- These low frequency vibrations LFV consist of rumbling, clearly perceptible room surface vibrations and feelings of nausea or headaches caused by indeterminate sources



### Low Frequency Noise (LFN) Criteria (UK)

"Proposed criteria for the assessment of low frequency noise disturbance"

by Dr. A. Moorhouse, Dr. D. Waddington, Dr. M. Adams (2005)

\*add 5 dB for steady state noise\*add 5 dB for daytime noise

Hz	dB, Leq*
10	92
12.5	87
16	83
20	74
25	64
31.5	56
40	49
50	43
63	42
80	40
100	38
125	36
160	34


#### Example of LFN (@ 63 Hz):



EFN criteria — LFN criteria +5dB — LFN criteria +10dB



### What are EMF's?



- Electro-magnetic fields are fields of magnetism which are either naturally there or induced by or created to induce electrical current
- There are two types of magnetic fields:
  - static fields: around a magnet (earth's magnetic poles, direct current (DC) electricity batteries)
  - alternating fields: moving magnetic field (electric motor or alternating current (AC) electrical generator)



#### How do we measure EMF's?

- There are two units used to measure magnetic fields, Teslas (metric) and Guass
  - typical exposures are usually below 1 milliGuass (mG) or 0.1 microTeslas ( $\mu$ T), or 10 mG = 1  $\mu$ T
- Frequency is also a factor which is measured in Hertz (Hz)
  - typical alternating current electricity (what comes out of your electrical plugs) is provided at 60 Hz but electronic equipment may change the frequency (e.g. computer screens)





## Measure in all 3 directions:

X



#### Root mean square average

 The root mean square (RMS) average measurement is the result of the three directions and is calculated as follows:

$$H = (x^2 + y^2 + z^2)^{\frac{1}{2}}$$



# Identification without meters:

- Interference with the picture on computer screen indicates a field 50-150 mG at the screen
- Transistor radio interference begins at about 50 mG
- Look for electrical panels and figure out where electrical lines go
- Talk to electricians and maintenance people



## What are typical EMF exposure levels

Computer screen (30 cm away) Fluorescent light (6" away) Pencil sharpener (at source) **Underneath power lines** Clock radio (4" away) TV (more than 3 feet away) Electric shaver (at source) Hair dryer (at source) Vacuum cleaner (at source)

1-2 mG 30-50 mG 1800 mG 25-40 mG 1-5 mG 0.5-1.5 mG >2000 mG >2000 mG >2000 mG



#### **Official Exposure Standards:**

- International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines general population 833 mG occupational 4166 mG
- American Conference of Governmental Hygienist (ACGIH) Threshold Limit Value (TLV<sup>®</sup>):

occupational 10,000 mG ceiling

1000 mG for workers with pacemakers



#### **Other Standards:**

- Swedish Board for Technical Accreditation (SWEDAC) MPR III standard ("based on what is technically achievable and not on medical or epidemiological research") or Swedish Confederation of Professional Employees (TCO-99), both:
  - 2.0 mG at 30 cm in front and 50 cm around monitor



#### **Exposure Zones:**

below 1 mG no evidence of problems (no source background exposure) 1-4 mG dividing line for some studies 4-20 mG dividing line for stronger studies 20-200 mG high exposure (computer monitor interference) 200-10,000 mG occupational standard range



### Sampling strategies:

#### Measure area levels

- spot measurements
- maximum or RMS (3 axis) levels
- find magnetic field source
- measure source strength

#### Measure personal exposure

- time weighted average
- datalogging (time logging)
- time and space logging (GPS)



#### **EMDEX meters**

EPRI

World Class EMF Instruments Used in 35 Countries Around the World









# Sampling strategies (sampling objectives):

#### Measure area levels

 locate sources and rearrange/relocate to avoid proximity to high level sources

#### Measure personal exposure

 used for detailed documentation, serious investigations and research



### **Prevention Options:**

- The following options have been considered in the literature as appropriate response to concerns about the health effects of magnetic fields:
  - Do nothing: alarm/stress is more detrimental than actual proven health effects
  - Cautious Inaction: there is not enough science yet to to justify doing anything, but maybe later ...
  - Prudent Avoidance: despite the lack of science, if it doesn't cost much reduce exposure why not avoid it?
  - Precautionary Principle: lack of certainty should not delay action if possible effect suggested

Aggressive Prevention: legislation justified by costbenefit probability analysis and ethical imperatives



### The choice is yours ...

- There is enough evidence available to select studies which will support each of the 5 options
- A balanced overall review would probably tend towards second or third options ("cautious inaction" or "prudent avoidance")



... but measuring the environment is only one half of the equation ...

- the "gold" standard for determining whether IAQ is adequate is the occupant's experience
- ASHRAE uses 80% satisfaction of untrained non-occupant visitors
- need a systematic way of collected input from occupants

... but what about other sources of dissatisfaction?





### **IAQ Survey Instrument:**

- since "Sick Building Syndrome" is a symptom based "diagnosis", occupant symptom experience must be assessed
- "SBS" cannot be diagnosed for a single individual in isolation from the symptom experience of fellow occupants
- we use a <u>validated</u> tool for assessing symptom rates



# Survey Instrument & Methodology:

use Swedish "MM-040 Questionnaire":

 "Questionnaire as an Instrument when Evaluating Indoor Climate", Healthy Buildings '88, Vol 3 p139-145 (1988)

 compare with data for buildings without air quality problems (206 respondents):

> "Carbon Dioxide, Particulates and Subjective Human Responses in Office Buildings Without Histories of Indoor Air Quality Problems", Appl Occup Environ Hyg J <u>7</u>:101-111 (1992)



During the last <u>3 months</u> have you had any of the following symptoms?				If YES: Does the symptom improve when you are away from work?	
	Yes, often (every week)	Yes, Some times	No, Never	Yes	Νο
Fatigue Feeling heavy-headed Headache		2 2 2 2	$ \begin{array}{c}     3 \\     3 \\     3 \\     3 \end{array} $		2 2 2 2
Nausea/dizziness Difficulties conc. Itching, burning or irritation of the eyes			$   \begin{bmatrix}     3 \\     3 \\   \end{bmatrix}   _3 $		



During the last <u>3 months</u> have you had any of the following symptoms?			If YES: Does the symptom improve when you are away from work?		
	Yes, often (every week)	Yes, Some times	No, Never	Yes	No
Irritated, stuffy/runny nose Hoarse, dry throat Cough			$   \begin{bmatrix}     3 \\     3   \end{bmatrix}   $		2 2 2 2
Dry or flushed facial skin Scaling/itching scalp/ears Hands dry, itching, red skin			$ \begin{array}{c}     3 \\     3 \\     3 \\     3 \end{array} $		2 2 2 2

|/

#### Symptoms:





Do the same with perceptions of the indoor environment:



Have you been bothered during the <u>last three months</u> by any of the following factors at your work place?	Yes, Often (every week)	Yes, Someti mes	No, Never
Draft Room temperature too high Varying room temperature			$ \begin{array}{c}     3 \\     3 \\     3 \\     3 \end{array} $
Room temperature too low Stuffy "bad" air Dry air			
Unpleasant odour Static electricity, causing shocks Second-hand smoke			
Noise Light that is dim or causes glare Dust and dirt			

#### **Environmental Perceptions:**





#### **Confounders:**

 MM-040 includes questions about workplace stress and personal health (i.e. allergic conditions:)





#### **Personal Health Conditions:**





#### Hayfever:







#### Workplace Stressors:

	Yes, often	Yes, some- times	No, seldom	No, never
Do you regard your work as interesting and stimulating?		<b>2</b>	<b>3</b>	4
Do you have <u>too much work</u> to do? Do you have any opportunity to <u>influence</u> your working conditions?				□ 4 □ 4
Do your fellow workers <u>help</u> you with problems you may have in your work?				4

i.e. job content, pace, control, support



### **Work Conditions:**







#### Influence on working conditions:





#### **Further Stress Questions:**

- The authors of the JCQ survey have created weighted scales which can be calculated from the responses
- Two of these scales (decision latitude and job demands) are graphed against each other and the lower right quadrant is the high job strain category (using US national male/female means)

(http://www.workhealth.org/strain/jsform.html)





Source: http://www.workhealth.org/strain/jsdef2.html

## Decision Latitude & Job Demands Scores:



job demands






### **JCQ: technical staff**





## JCQ: administrative staff





# **JCQ: grad students**





# JCQ: post doc













#### **JCQ: custodial staff**





# **JCQ Findings:**

- 19 respondents (7.4%) fell into the high job strain quadrant
  - 1/63 (2%) from the faculty job category
  - 1/12 (8%) from the technical job category
  - 1/21 (5%) from the post doc job category
  - 9/104 (9%) from the grad student job category
  - 0/4 (0%) from the research asst job category
  - 0/15 (0%) from the admin job category
  - 2/5 (40%) from the trades job category
  - 3/4 (75%) from the custodial job category



#### Specific Workplace Measurements & Symptom Logs:

- A datalogging air monitoring machine placed in selected locations
- The machine logs the following parameters over this time (5 minute averaging):
  - temperature (°C) (temp)
  - relative humidity (%) (RH)
  - carbon dioxide (in ppm) (CO<sub>2</sub>)
  - carbon monoxide (in ppm) (CO)



 Occupants located near monitor are asked to fill out an workplace conditions/symptom log each hour while the monitor is in their work area (1 day)



SYMPTOMS	DEGREE OF IRRITATION
eyes	$\frac{1}{1} - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9$ none slight noticeable annoying disabling
nose	$\frac{1}{1} - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9$ none slight noticeable annoying disabling
throat	$\frac{1}{1} - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9$ none slight noticeable annoying disabling
chest	$\frac{1}{1} - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9$ none slight noticeable annoying disabling
skin	$\frac{1}{1} - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9$ none slight noticeable annoying disabling
headache	<u>1</u> - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 none slight noticeable annoying disabling
fatigue	$\frac{1}{1} - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9$ none slight noticeable annoying disabling



# Headache vs. CO<sub>2</sub>





# Headache vs. CO<sub>2</sub>



# Headache vs. CO<sub>2</sub>









# **Early interventions:**

 symptoms be viewed as lower part of the proverbial "occupational disease iceberg"







Health Canada Guide

Indoor Air Quality in Office Buildings: A Technical Guide



Canadä

Health Santé

Health Canada: "Technical Guide to IAQ Investigations" (93-EHD-166) available at:

http://publications.gc.ca/collections/Collection/H46-2-93-166Erev.pdf

Health Canada Guide Heatth Banté Canada Canada

Fungal Contamination in Public Buildings:

Health Effects and Investigation Methods



Health Canada: "Fungal Contamination in Public Buildings: Health Effects and Investigation Methods" (2004)

http://www.hc-sc.gc.ca/ewh-semt/pubs/air/fungal-fongique/index-eng.php



#### EPA (US) mould:



US EPA "Mold Remediation in Schools and Commercial Buildings" available at: http://www.epa.gov/mold/mold\_remediation.html



## IRSST (Quebec) guideline:

Studies and Research Projects

TECHNICAL GUIDE RG-089



Guide for the Prevention of Microbial Growth in Ventilation Systems



IRSST: Guide for the Prevention of Microbial Growth in Ventilation Systems http://www.irsst.qc.ca/media/documents/PubIRSST/RG-089.pdf

Jacques Lavole

#### **Tools for Schools**



#### US EPA "Tools for Schools"

http://www.epa.gov/iaq/schools/actionkit.html



### **Tools for Canadian Schools**



#### Indoor Air Quality Tools for Schools Action Kit for Canadian Schools

#### http://www.hc-sc.gc.ca/ewh-semt/pubs/air/tools\_school-outils\_ecoles/index-eng.php\_



... any questions? ...

