



Ten Ways To Improve Your Air Quality

Northern California Facilities Exposition

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by

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Indoor Environmental Engineering

Your IAQ Experts

Healthy Building Services • Diagnostic Services • Laboratory Services

Indoor Environmental Engineering (IEE) is a building science consulting firm with 30 years of experience diagnosing building air quality problems and designing healthy and energy efficient indoor environments in a wide range of building occupancy types, including office, hospital, school, laboratory, and single and multi-family residential.

Diagnostic Services. IEE utilizes annual proactive IAQ Checkups™ to help maintain comfortable work environments and identify IAQ problems early, thus minimizing occupant complaints. In response to occupant concerns, we utilize a hypothesis-based six-step protocol to quickly and accurately diagnose building air quality problems and prescribe effective mitigation measures.

Healthy Building Services. Building material emission testing/modeling, ventilation system performance assessments, construction & renovation practice plans, indoor air quality operation & maintenance procedures, and all USGBC LEED ventilation and indoor air quality testing certifications.

Laboratory Services. State-of-the-art analytical and ventilation laboratories.

**Indoor Environmental Engineering is committed to the advancement
of energy efficient buildings with healthy indoor environments.**



Francis (Bud) J. Offermann PE CIH

Licensed Professional Engineer - Mechanical Engineering

Certified Industrial Hygienist - ABIH

B.S. (1976) and M.S. (1985) in Mechanical Engineering

Staff Scientist: IAQ Program, Lawrence Berkeley Laboratory

Member of USBGC LEED EQ Technical Advisory Group

Co-Chair ISIAQ HVAC Hygiene Task Force

Member of ASHRAE Standard 62 Ventilation for Acceptable IAQ

Member of the Cal-OSHA IAQ Advisory Committee

Published 26 Peer-Reviewed Studies on Building Air Quality

IAQ Diagnostics/Mitigation in over 2000 Buildings (30 years - 2009)

BOC 106 – Indoor Air Quality - Instructor

Is IAQ a New Issue ?



“I considered fresh air an enemy, and closed with extreme care every crevice in the room I inhabited. Experience has convinced me of my error. I am persuaded that no common air from without is so unwholesome as the air within a closed room that has been often breathed and not changed.”

**Benjamin Franklin
(18th Century)**

IAQ Myths



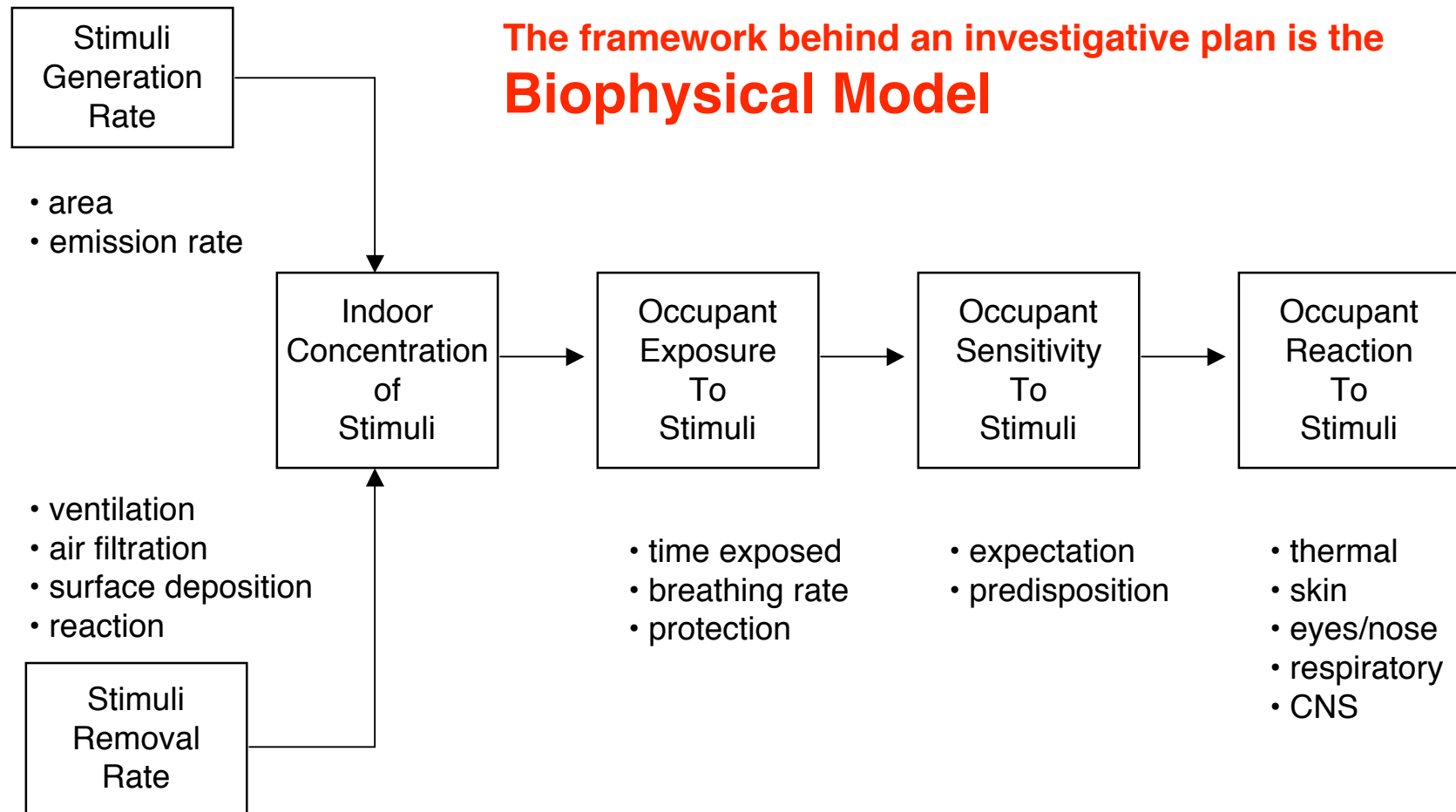
Popular Indoor Air Quality Myths

- Man-made chemicals are bad, and natural chemicals are OK
- Natural ventilation (e.g., openable windows) is superior to mechanical ventilation
- Indoor plants clean the air of air contaminants
- “Tight” buildings cause indoor air quality problems
- Air cleaners eliminate all pollutants
- Carbon dioxide (CO₂) is a major cause of indoor air pollution

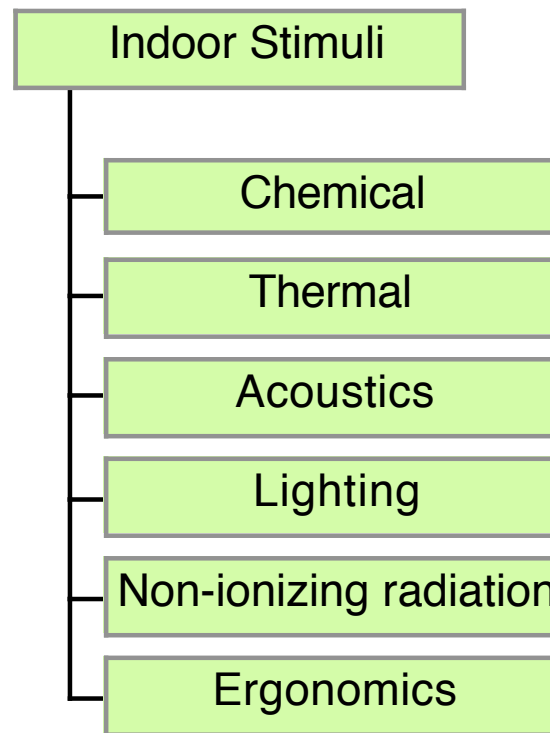
Understanding IAQ



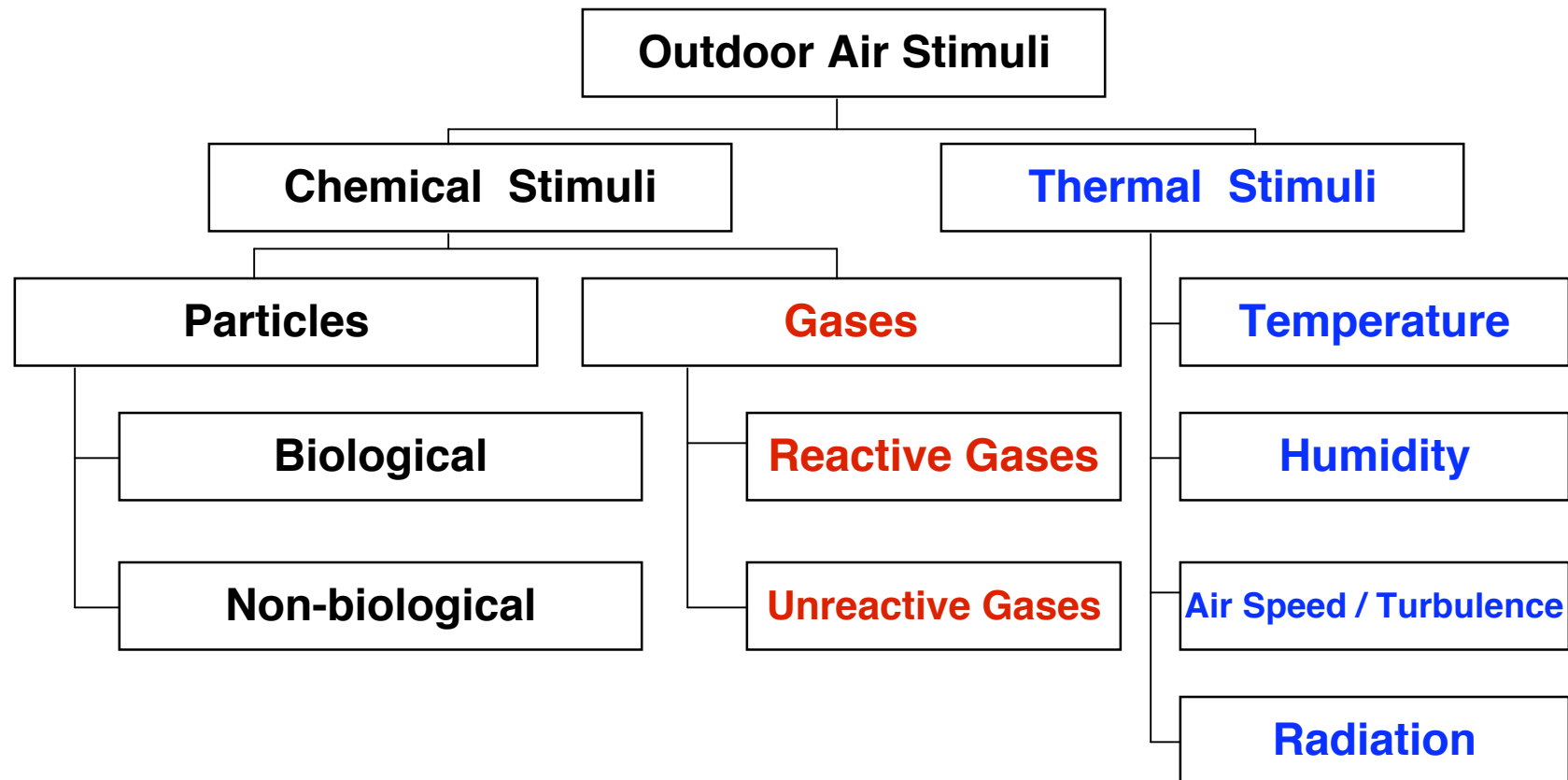
The framework behind an investigative plan is the **Biophysical Model**



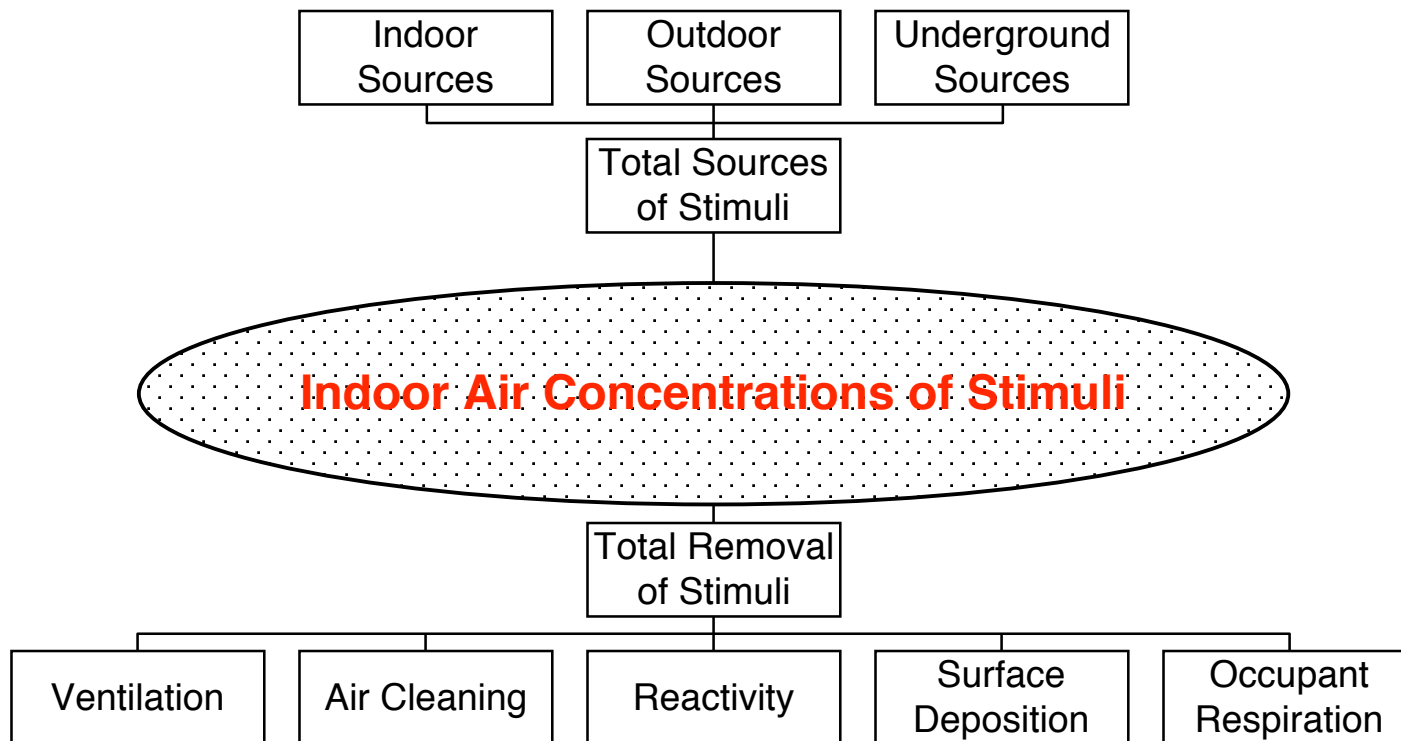
Understanding IAQ



Understanding IAQ



Understanding IAQ



Understanding IAQ



What is a “Sick Building” ???

There are no “Sick Buildings”, just “Misunderstood Buildings”

Building Related Illness (BRI) is an illness acquired by an occupant that is causally linked to specific physical or chemical environmental stimuli in the building,

Sick Building Syndrome (SBS) is an illness or discomfort that is experienced by an occupant to be linked to the occupancy of the building but is not causally linked to specific physical or chemical environmental stimuli in the building

Also, SBS more often than not means “Sick Buildings Suck”

Understanding IAQ



What is a “Healthy Building” ???

In a healthy building there are:

- no known contaminants at concentrations leading to exposures determined by cognizant authorities to be harmful
- and a substantial majority of the occupants (80%) express no dissatisfaction with thermal, odor, or irritant perceptions.

Also, Healthy Buildings don't suck, they blow.

IAQ Economics



HEALTHY BUILDINGS MAKE GOOD ECONOMIC SENSE (\$\$\$)

BUILDING COSTS

• Construction Costs	- \$16 per ft ² - yr
• Operation Costs	- \$4 per ft ² - yr

Total Costs	- \$20 per ft ² - yr

EMPLOYEE COSTS - \$500 per ft² - yr

Therefore a 1% increase in worker productivity justifies a 25% increase in building construction and operating costs.

IAQ Economics



HEALTHY BUILDINGS MAKE GOOD ECONOMIC SENSE (\$\$\$)

In addition to worker productivity \$ savings other savings include:

- Reduced Tenant Complaints, Reduced Trouble Calls
- Reduced Industrial Hygiene/Engineering Testing Costs
- Reduced Liability Risks
- Increased Rentability

Diagnosing IAQ Problems



Commonly Encountered Occupant Complaints

- Thermal Comfort
- Odors
- Eye/Nose/Throat Irritation
- Skin Irritation

Diagnosing IAQ Problems



There are four necessary ingredients for all IAQ problems.

The Four Ps

- People
- Pollutant
- Pathway
- Pressure

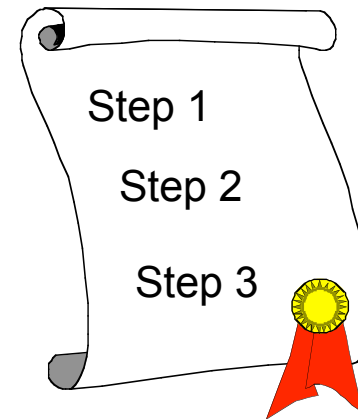
Remove any one ingredient - and no more problem

Diagnosing IAQ Problems



The main and essential TOOL for ALL types of IAQ investigations is a rational

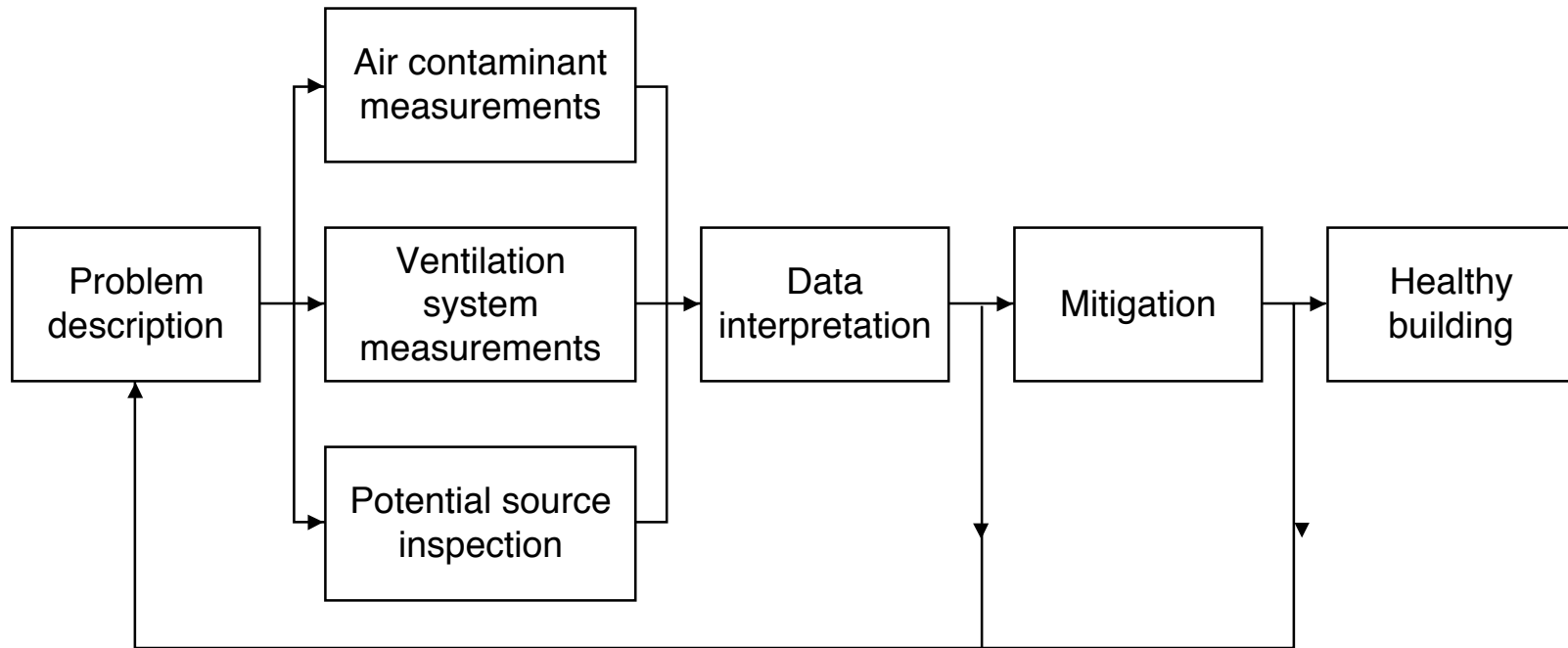
INVESTIGATIVE PLAN.



Diagnosing IAQ Problems



INVESTIGATIVE PLAN for Reactive Investigations- Occupant Complaints



Ventilation Standards



California Building Code Outside Air Requirements

Offices or Classrooms : 15 cfm/occupant or 15 cfm/100 ft², whichever is greater

ASHRAE Ventilation Standard 62.1-2004 Outside Air Requirements

Offices: 5 cfm/occupant + 0.06 cfm/ft²

Classrooms: 10 cfm/occupant + 0.12 cfm/ft²

Ventilation Standards



Outside Air Requirements (for an office with 5 occupants and 1,000 ft² floor area)

	<u>California Title 24</u>	<u>ASHRAE 62.1- 2004</u>
cfm	150 (= 150-bldg > 75-occupants)	85 (= 25 + 60)
cfm/occupant	30	17
cfm/ft ²	0.15	0.085

Ventilation Standards



Other Ventilation Standards

Cal-OSHA 5142

- Requires ventilation system to be operated as designed whenever building is occupied except for a maximum of 90 hours per year (e.g. maintenance) and
- Written documentation of operations and maintenance for past 5 years - deliverable within 48 hours to any employee requesting such records.

Air Contaminant Standards



Air Contaminant Standards

<u>Contaminant</u>	<u>Non-Industrial Guidelines</u> (2-4 Hour)	<u>Source</u>	<u>Cal/OSHA PEL</u> (8 Hour)
Carbon Monoxide:	≤ outdoors and <9 ppm	NAAQS	25 ppm
Carbon Dioxide:	1,000 ppm	ASHRAE	5,000 ppm
Total Volatile Organic Compounds (TVOC):	1,000 µg/m ³	IEE	NA
Formaldehyde:	0.027 ppm	CARB	0.75 ppm
Nitrogen Dioxide:	0.25 ppm (1 hour)	NAAQS	1 ppm (15 minutes)
Ozone:	0.12 ppm	NAAQS	0.12 ppm
Respirable Particulate Matter:	50 µg/m ³	NAAQS	5,000 µg/m ³
Tobacco Smoke Particles			NA
-Visibility:	500 µg/m ³	IEE	NA
-Odor and Irritation:	50 µg/m ³	IEE	NA
-Health:	1 µg/m ³	IEE	NA
Fungi (on a genera basis):	< outdoors	IEE	NA
Bacteria (total):	< 500 CFU/m ³	IEE	NA
Fibers:	13 fibers/in ²	IEE	1 fiber/cc
Temperature:	72 ±2°F	ASHRAE	NA
Humidity:	45 ±15%	ASHRAE	NA

Mitigating IAQ Problems



How Can IAQ Problems Be Solved ?

Ventilation

- Natural infiltration
- Mechanical ventilation
 - general dilution ventilation
 - local exhaust ventilation

Air Cleaning

- Particulate phase air cleaning
 - mechanical filtration
 - electrostatic precipitation
- Gas phase air cleaning
 - absorption
 - adsorption
 - catalytic conversion

Source Control

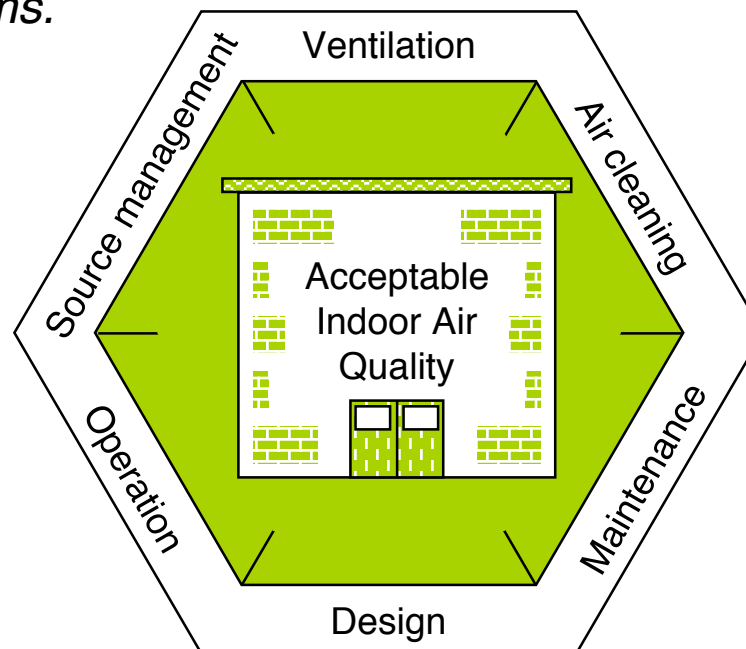
- Removal
- Isolation
- Modification

Preventing IAQ Problems



IAQ Problem Prevention

Designing Buildings for Good IAQ and Implementation of an IAQ Management Plan sets flexible and specific activities for preventing and resolving IAQ problems.



Preventing IAQ Problems



Implement an IAQ Management Plan

An IAQ Management Plan Includes:

- Designate Responsibilities of IAQ Team Members
- Select an IAQ Manager (Overall Responsibility for IAQ)
- Establishing a IAQ Baseline for your Building
- Managing and Improving the IAQ Baseline
- Communicate with Building Occupants their Role in the Plan
- Establish Procedures for Responding to IAQ Complaints

Healthy Building Design



- 1.) **Site Evaluation**
- 2.) **Architectural Design**
- 3.) **HVAC Design**
- 4.) **Building Materials/Furnishings Selection**
- 5.) **Construction Contaminant Controls**
- 6.) **IAQ Commissioning**

Healthy Building Design



Building Materials/Furnishings Selection

- Determine Material and Furnishing Loadings
- Determine Material and Furnishing Emissions
- Calculate Contaminant Concentrations
- Compare Projected Concentrations to Guidelines
- Make Adjustments to Achieve Acceptable Indoor Contaminant Concentrations
- Default Emission Specifications

Healthy Building Design



Healthy Building Design



Healthy Building Design



California Architectural Specification - 01350

http://www.dhs.ca.gov/iaq/VOCS/Section01350_7_15_2004_final_plus_addendum-2004-01.pdf

Requires emission rate of chemicals from building materials and furnishings be measured and that individually each chemical does not exceed one half of the OEHHA Chronic Reference Exposure Guideline.

CHPS Low Emitting Materials (LEM) Table

http://www.chps.net/manual/lem_table.htm

Healthy Building Design



Construction Contaminant Controls

- **Adjacent Occupied or Non-renovation Spaces**
- **Protection of Building Materials from Construction Contaminants**
- **HVAC Protection**
- **Building Flush-Out (100% outside air, 24/7 operation, 2 weeks - USGBC LEED)**



The IAQ TOP 10 Fixes

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(complete paper available at above website)

Top 10 IAQ Fixes



The following are my top 10 things to check and fix to reduce indoor air quality complaints

These were derived from my 30 years experience and over 2,000 IAQ investigations

Top 10 IAQ Fixes



IAQ Issue #1

Air Temperature (70-74 °F)



Wired deep into our brains is a strong aversion to warm air. This warm air is often judged as stale or not being fresh. Sometimes a “suffocation panic” reaction occurs.

“Ventilation should be served like champagne, cool and dry”.
My mentor: Professor Ole Fanger - Technical University of Denmark

Top 10 IAQ Fixes



IAQ Issue #2

Air Pressure (positive 0.01-0.03 inches of water with respect to outdoors and special use areas)

Buildings with negative air pressures are very unforgiving to many types of problems (e.g. odors from dry sewer traps, moisture condensation in walls)

Remember “Sick buildings SUCK and healthy buildings BLOW”

Top 10 IAQ Fixes



IAQ Issue #3

Outdoor Air Ventilation (at least ASHRAE 62.2 minimums, or preferably 15 cfm/occupant or 15 cfm/100 ft², whichever is greater)

Make sure that the thermostats for small unit ventilators have the fan switch set in the “on” position not the “auto” position.

Remember “Build it tight, but ventilate it right”.

Top 10 IAQ Fixes



IAQ Issue #4

Outdoor Air Inlet (locate inlet away from sources of air contaminants and odors)

Locate the inlet away from stinky things such as sewer vents, kitchen, and bathroom exhausts, loading docks, garbage dumpsters, etc.

Remember “The nose of the building is the outdoor air inlet”.

Top 10 IAQ Fixes



IAQ Issue #5

Indoor Sources (use low emitting materials, isolate tenant improvement/construction areas, flush out areas following construction activities)

Select materials from the CHPS Low Emitting Materials (LEM) Table

http://www.chps.net/manual/lem_table.htm

Top 10 IAQ Fixes



IAQ Issue #6

Moisture (don't let materials get and stay wet for more than 2 days)

As described in the “California Builders’ Guide to Reducing Mold Risk”

<http://iee-sf.com/workshops-seminars/pdf/BuildersMoldGuide.pdf>

- 1.) keep the water away with proper site drainage
- 2.) keep the water out with proper window/door flashing, foundation water proofing, vapor retarder placement, and wall drainage systems, and
- 3.) limit mold growth while moisture dries out with selection of moisture tolerant materials.

Top 10 IAQ Fixes



IAQ Issue #7

Soiling Around Supply Air Diffusers (clean soiling around diffusers and improve air filtration)



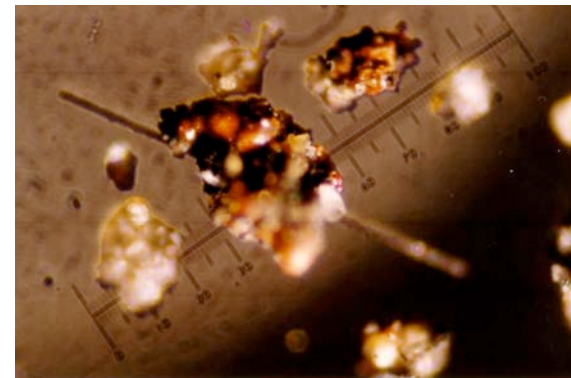
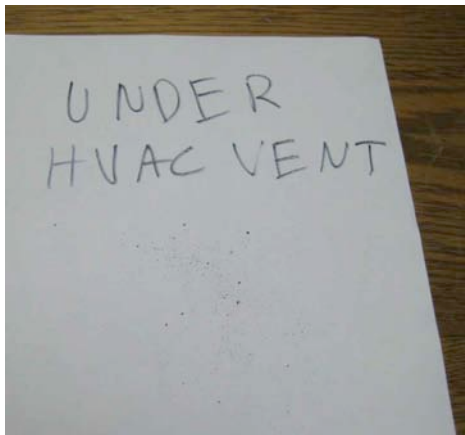
This is NOT an indication of a need to clean ducts rather, an indication of a lot of particles in the room air which deposit quickly near the diffuser because of the boundary layer effects caused by the jet of air at the diffuser.

Top 10 IAQ Fixes



IAQ Issue #8

Particle Emissions from Ventilation Systems (fix soundliner erosion and clean ducts)



Often caused by degrading soundliner. Disturbing for tenants to see on their work space and can cause skin irritation and upper respiratory irritation.

Top 10 IAQ Fixes



IAQ Issue #9

Air Filtration (minimum of MERV 8 and preferably MERV 11 or 13, no ozone, electrostatics, or UV)



Make sure filters do not become overloaded and that there is no air bypass in the filter rack.

Top 10 IAQ Fixes



IAQ Issue #10

Occupant Complaint/Response System (implement one, or get a tricorder)



Since we do not have Star Trek tricorders, we must rely on feedback from the occupants regarding the acceptability of the indoor air and this means having a formal complaint and response plan where the occupants can communicate with building operators.

The occupants are our IAQ sensors - use them.

Building Operator Certification



Level I Course Series

- BOC 101 – Building Systems Overview
- BOC 102 – Energy Conservation Techniques
- BOC 103 – HVAC Systems and Controls
- BOC 104 – Efficient Lighting Fundamentals
- BOC 105 – Environmental Health & Safety Regulations
- BOC 106 – Indoor Air Quality
- BOC 107 – Facility Electrical Systems

<http://www.theboc.info/>

Managing IAQ in Buildings



Conclusions

Having a robust IAQ Management Plan developed and implemented in buildings makes good economic sense especially in today's competitive market and with the increased awareness of IAQ.



Ten Ways To Improve Your Air Quality

??? Questions ???

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