

# Indoor Air Quality Lecture Topics

## INTRODUCTION

- Definition of IAQ
- Effects of indoor air pollution
- Sick buildings

## CAUSES OF IAQ

## PROBLEMS

- Sources indoor air pollution
- Environmental factors
- Acceptable IAQ

## INVESTIGATION OF IAQ

- Assessment procedures
- Building system evaluation

## CONTROL OF IAQ

- IAQ standards
- Practical control methods

## FURTHER READING

# INTRODUCTION: DEFINITION OF IAQ

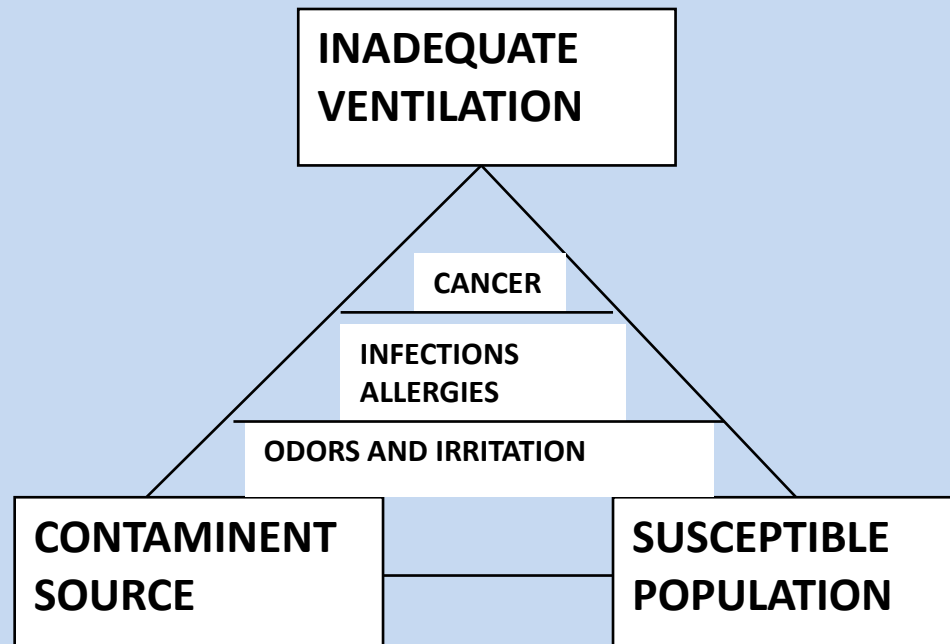
**How well does the indoor air satisfy 3 basic requirements?**

- **Human comfort from thermal viewpoint**
- **Maintenance of normal concentrations of respiratory gases; and**
- **Control of contaminants to levels below health or odor discomfort thresholds.**

# INTRODUCTION: EFFECTS OF IAQ

**IAQ RESULTS IN 3 EFFECTS ON PEOPLE**

- 1. comfort, 2. acute health effects, and**
- 3. chronic health effects.**



# INTRODUCTION: EFFECT OF IAQ

- **Proportional to concentration & duration**
- **Instantaneous vs delayed**
- **Difficult to Assess**
- **Partly Psychological**
- **Impacts productivity/morale**
- **Dramatic Impact on Medical Costs**

# INTRODUCTION: EFFECTS OF IAQ

- **Respiratory cancer**
- **Chronic obstructive pulmonary disease**
- **Infectious disease and microbial toxins**
- **Immunologic disorders**
- **Irritation phenomena**
- **Odors**

# INTRODUCTION: SICK BUILDINGS SYNDROME (SBS)

(20%+ POPULATION HAVE SYMPTONS = SBS)

- Eye, nose or throat irritation
- Irritability
- Nose bleeds
- Headaches
- Dry skin, rashes
- Nausea
- Ex: 17 million doctor visits/yr
- Fatigue and dizziness
- Nasal congestion
- Difficulty in concentration
- Difficulty in breathing



# **INTRODUCTION**

## **BUILDING RELATED ILLNESS (BRI)**

### **Characteristics:**

- well documented
- defined diagnostic criteria
- recognizable causes
- defined treatments

### **Examples :**

- hypersensitivity pneumonitis
- Pontiac fever
- Legionnaire's disease
- Humidifier fever.

# CAUSES OF POOR IAQ

- **Construction of more tightly sealed buildings**
- **Reduced ventilation rates to save energy**
- **Synthetic building materials and furnishings**
- **Use of chemically formulated personal care products, pesticides, and household cleaners.**

# CAUSES OF POOR IAQ: SOURCES OF CONTAMINATION

- **POLLUTANT CLASSES & TYPICAL EXAMPLES**

- **Combustion products** : Carbon monoxide, nitrogen dioxide, sulfur dioxide, carbon dioxide, tobacco smoke
- **Volatile organic chemicals**: Pesticide and fungicide components, alcohols, benzene, esters, chloroform
- **Respirable particulates**: Asbestos, fiber glass, inorganic and organic dusts, frayed materials, pollen
- **Respiratory products**: Water vapor, carbon dioxide
- **Biologics and bio-aerosols**: Molds and fungi, bacteria, viruses, non-viable microbial particulates
- **Radio-nuclides**: Radon, radon progeny (1000's death/yr)
- **Odors**: Oder associated with any of above agents

# CAUSES OF POOR IAQ: ENVIRONMENTAL FACTOR PERCEPTION

| <b>TYPICAL ENVIRONMENTAL FACTORS</b>  | <b>TYPICAL RESPONSE</b>                                |
|---|--|
| <b>Warm and cool air, odorous gases and vapors, irritating glare, and noise</b>   | <b>Perceived and result in physiological strains</b>   |
| <b>Odorless gases and vapors (carbon monoxide, radon), carcinogenic compounds, gases and vapors with odor recognition thresholds above irritation thresholds (formaldehyde, ozone), inert particulates (asbestos, glass fibers), and bio-aerosols (bacteria, fungi, spores)</b> | <b>Not perceived but cause physiological strains</b>   |
| <b>Labor management climate, collegial relations, privacy (the lack of it) and job satisfaction</b>   | <b>Perceived but don't cause physiological strains</b> |

# **CAUSES OF POOR IAQ: ACCEPTIBLE IAQ**

- **Air in which there are no known contaminants at harmful concentrations (OBJECTIVE)**
- **Air with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction (NON-OBJECTIVE)**

# **INVESTIGATING IAQ ASSESSMENT PROCEDURES**

## **STEP 1: PRELIMINARY ASSESSMENT (Usually in house)**

- **Self-evaluation**
- **Data gathering and observation efforts**
- **Historical information**
- **Info on symptoms employees have been experiencing and over what period of time**
- **Personal interviews**

# **INVESTIGATING IAQ ASSESSMENT PROCEDURES**

**Step 2: WALK THROUGH INSPECTION (in house or specialized consultant)**

- Conducted by trained in-house/consultant staff**
- Many IAQ problems identified**
- Walk-through evaluation needed for additional background information & visual appreciation for the building/HVAC design**
- Provides thorough characterization of building with respect to potential sources of contaminants**

# **INVESTIGATING IAQ ASSESSMENT PROCEDURES**

## **STEP 3: SIMPLE DIAGNOSIS (multi-disciplinary team)**

- **More extensive analytical procedures conducted**
- **Limited measurements of implicated factors or surrogates, and possible medical assessment may be conducted.**
- **On-site environmental monitoring may be used to conform or to rule-out a number of problem source possibilities identified from the earlier steps. Most common instruments that may be used are: electronic instruments to measure temperature, humidity, carbon dioxide, and air flow.**

# **INVESTIGATING IAQ ASSESSMENT PROCEDURES**

## **STEP 4: COMPLEX DIAGNOSTICS (multi disciplinary team)**

- **Involves broad in-depth testing, qualitative studies of factors in combination, and medical examination**

## **STEP 5: MONITORING AND RECURRENCE PREVENTION**

- **Observation, testing as warranted**
- **Preventive measures**

# INVESTIGATING IAQ PROCESS AFTER EACH STAGE

*Investigating stage “X” activity*



*Suggested remedies*



*Building*



*Corrective Action*



*monitoring*



*Improved IAQ?*

# INVESTIGATING IAQ

## BUILDING SYSTEM EVALUATION

### *Architectural aspects*

- Aesthetics
- Use of different materials, components, and assemblies
- Building structure and internal furnishings
- Outdoor air intake
- Architectural setting

# INVESTIGATING IAQ

## BUILDING SYSTEM EVALUATION

### *Design of HVAC system –*

Ensure that:

- At least the minimum quantity of outdoor fresh air is provided.
- If VAV system, outdoor fresh air is maintained under low load conditions
- Correct filtering system is employed
- Specialized systems requiring differential pressure control prevent migration of room-developed contaminants
- Sufficient & proper controls are in place

# INVESTIGATING IAQ BUILDING SYSTEM EVALUATION

## *Operation and Maintenance*

- Starts with Design
- Verify correct operation periodically
- Maintain surfaces dry/biological material free
- Maintain regular log of pertinent IAQ properties for all spaces
- Optimize system to include efficiency
- Use predictive/preventative maintenance

# INVESTIGATING IAQ BUILDING SYSTEM EVALUATION

## ASHRAE Standard 62

### Section 8 offers guidance

- what ventilation components should be maintained
- what tasks should be performed
- minimum frequency for performing those tasks.

# Indoor AirPlus Program

**Partnership among EPA, builders, standards verification organizations, utilities, and public health and indoor environmental organizations to improve indoor air in new homes.**

**To Earn Indoor AirPlus label, a home must meet strict EPA guidelines ensuring good indoor air quality as well as Energy Star guidelines that typically make them 20 to 30 percent more efficient than standard homes.**

# CONTROLLING IAQ

## OBJECTIVES:

- **(1) meeting the statutory IAQ standards**
- **(2) maintaining the quality needed for safety and health**
- **(3) satisfying comfort and productivity needs.**

# CONTROLLING IAQ

- **ASHRAE 62.1-2007, Ventilation for Acceptable Indoor Air Quality.** Specifies minimum ventilation rates and indoor air quality that will be acceptable to human occupants to minimize the potential for adverse health effects.
- **OSHA [Section 5\(a\)\(1\)](#)**  
employers to "furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees".
- **OSHA [Section 5\(a\)\(2\)](#)** requires employers to "comply with occupational safety and health standards promulgated under this Act".

# **CONTROLLING IAQ**

## **TWO METHODS OF CONTROL:**

- **VENTILATION RATE PROCEDURE**  
**SPECIFIED RATE AND QUALITY OF OA**
- **INDOOR AIR QUALITY PROCEDURE**  
**FEEDBACK CONTROL OF VENTILATION AIR**  
**BASED ON KNOWN CONTAMINANTS**

## FURTHER READING

- Indoor Air Quality Home Page,  
United States Environmental  
Protection Agency,  
<http://www.epa.gov/iaq/>.