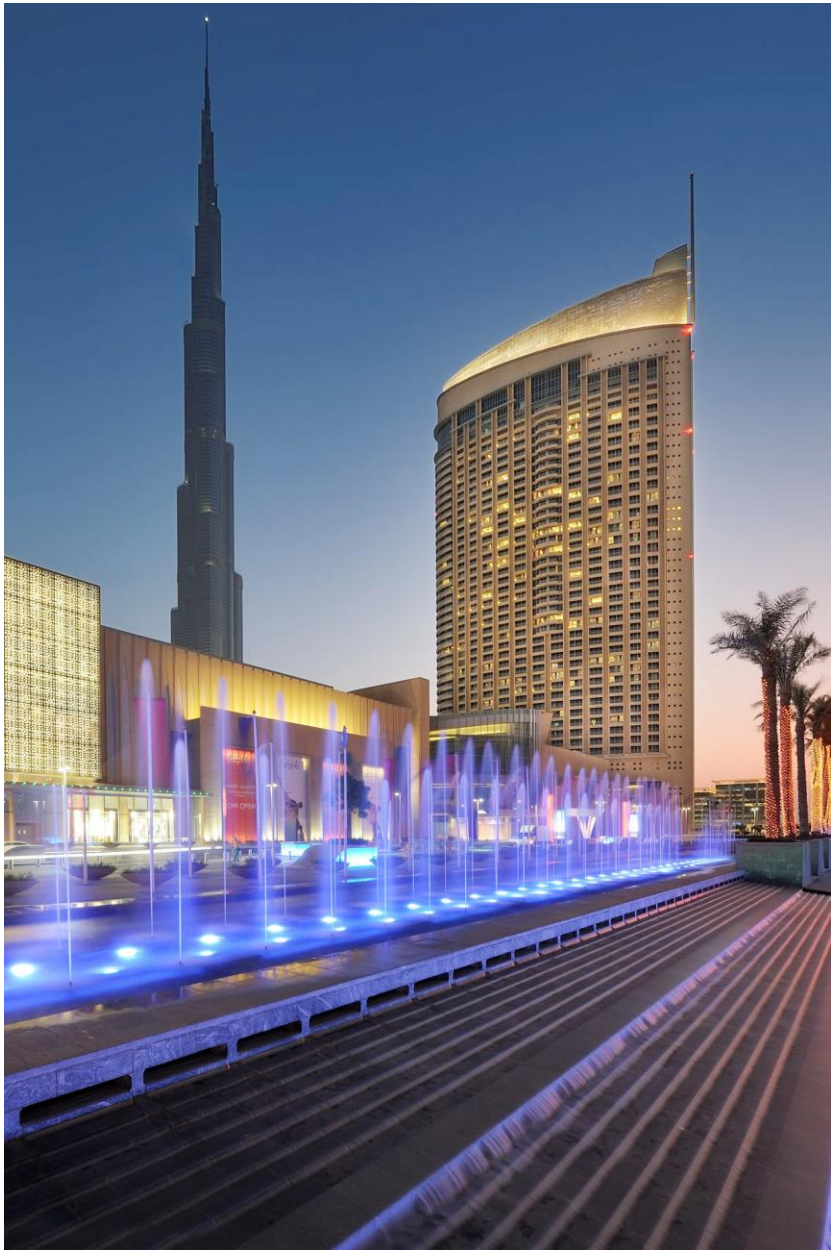
DRI
Innovative Air Solutions

The AIR is changing Are you?



DRI
Innovative Air Solutions

Index

- What is Indoor Air Quality
- Indoor Air Pollutants
- Effects of Poor IAQ – SBS & BRI
- IAQ Enhancers
- Method of Ventilation – Energy Recovery Devices
- Total Energy Recovery Wheel
- OutDoor Pollution
- Using Fresh Air to achieve IAQ in polluted Cities

Target to design an efficient building and increase the value

- Reducing energy use:
  - Rationalizing the orientation of building;
  - Improving facade and window design;
  - Improving the performance of HVAC-systems;
  - Adding renewable energy production.
- Improving Indoor Environment Quality:
  - Thermal comfort;
  - Indoor air quality (IAQ);
  - Lighting environment;
  - Acoustic environment;
  - Visual environment.

DRI
Innovative Air Solutions

What is IAQ ?

IAQ Stand for ‘Indoor Air Quality’

Indoor Air Quality (IAQ) refers to the Nature of the conditioned (Heat/Cool) air that circulates throughout space/area where we work and live i.e. the air we breathe during most of our lives.

Innovative Air Solutions

IAQ

refers not only to comfort which is affected by :

- Temperature
- Humidity
- Odour

but also to

- **Harmful chemicals and**
- **Biological contaminants present in the conditioned space**

DRI
Innovative Air Solutions

A Common MYTH

Air pollution occurs only Outdoors.
or
In Industrial Environment.

TRUTH!!

Air inside Conditioned Space can be substantially more polluted than outdoor air.

DRI
Innovative Air Solutions

ANOTHER FACT

HUMAN BEING SPEND 80 to 90% TIME INDOOR

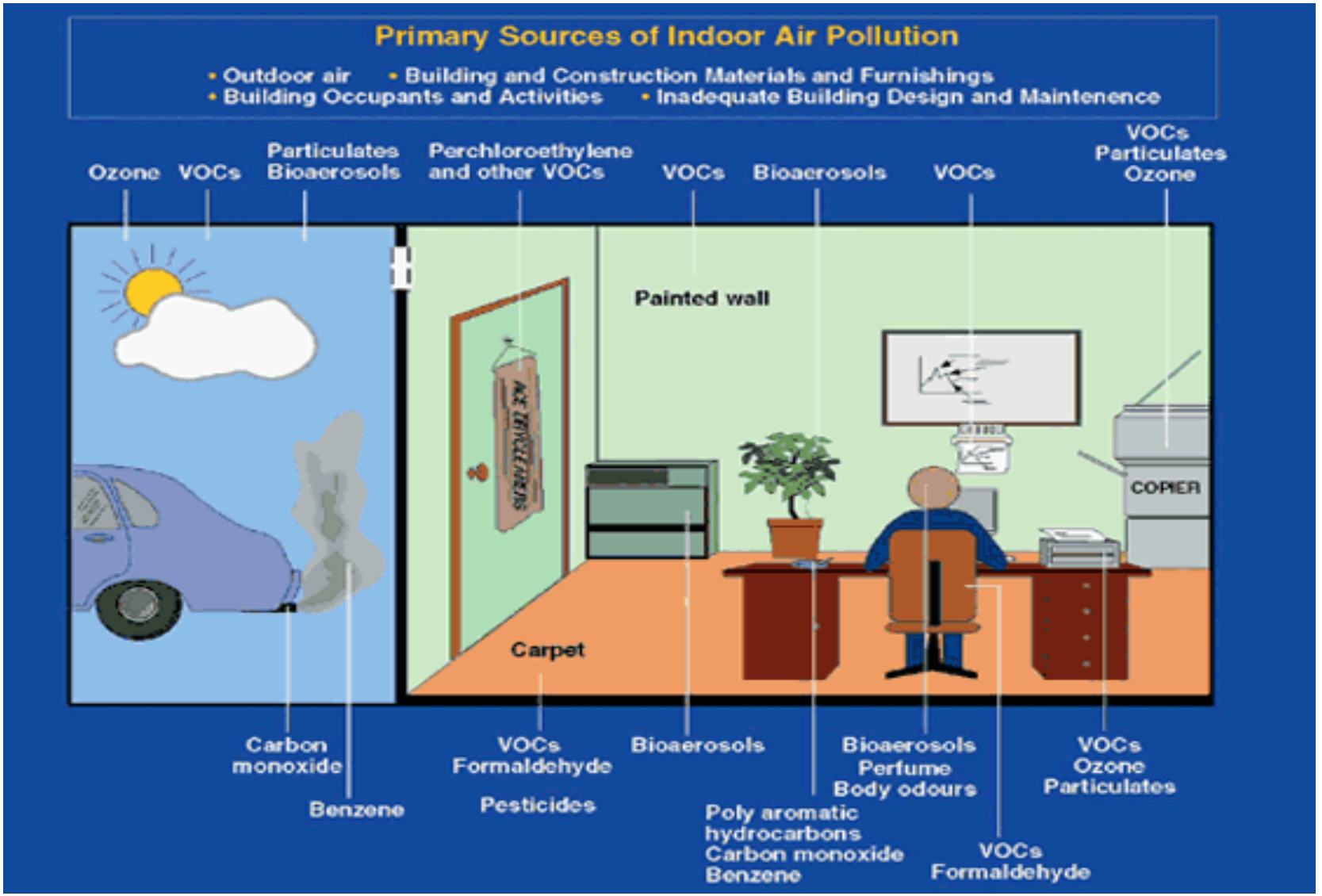
Research clearly indicates that we spend 90 % of our time indoors and the growing scientific evidence that the air indoor is almost 10 to 100 times more polluted than outside, the risk to health is much greater indoors than outdoors

Innovative Air Solutions

INDOOR AIR POLLUTANTS

- Formaldehydes
- Radon
- Asbestos
- VOC from solvents,paints, varnishes,carpets etc.
- Biological organisms like bacteria ,viruses , fungus
- Odours and dust &
- Environmental tobacco smoke (ETS)
- All outdoor pollutants -sulphur, nitrogen dioxide, carbon monoxide, high pollen counts, pesticides, chemicals etc.

Primary Sources of Indoor Air Pollution



POOR IAQ - HEALTH CONSEQUENCES

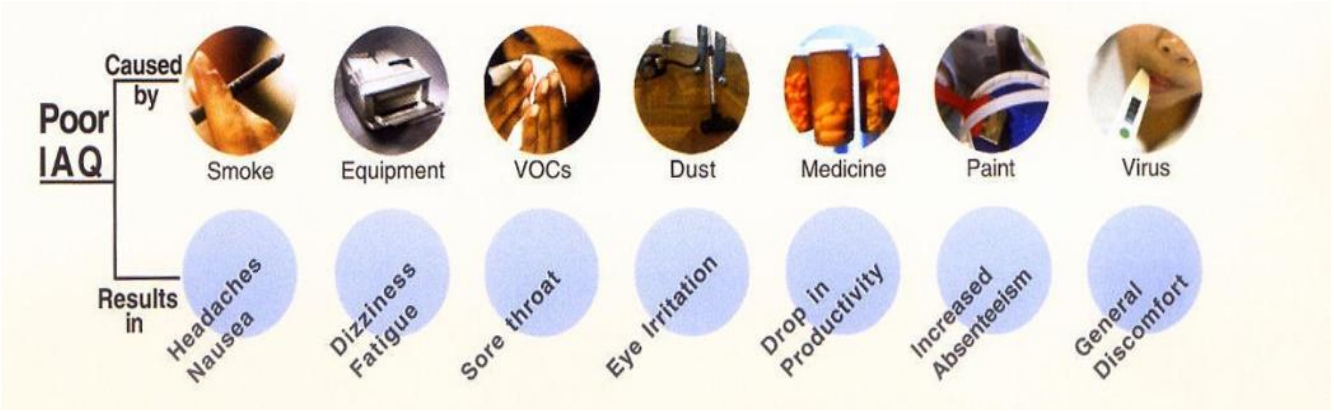
CATEGORIZED AS "SBS" & "BRI"

SBS -SICK BUILDING SYNDROME

- No specific illness or identifiable cause of discomfort
- Cluster of complex irritating symptoms incl.
  - Headache,nausea, fatigue
  - Dizziness, lethargy
  - Respiratory problems
  - Coughing, wheezing
  - Eye, nose & throat irritation
  - Dry skin, skin rashes
  - Sensory discomforts

BRI -BUILDING RELATED ILLNESS

- A more serious condition
- Symptoms of diagnosable illness are identifiable
- Cause of illness directly attributable to environmental agents in air
- Diseases include :
  - Legionnaire's disease
  - Sensitivity pneumonitis



Monitoring IAQ – Ventilation Rate

CO_2 – The surrogate ventilation index

- Indoor Air Contaminants Are Difficult And Expensive To Detect And Measure
- ASHRAE Recognizes CO_2 Levels As The Reliable Surrogate Index To Monitor Indoor Air Quality
- High Concentrations of CO_2 indicate high pollutant levels which Cause Drowsiness and Discomfort and an Inability to Think, Reason, and Retain Information and Respond.
- ASHRAE- 62- 2001 Stipulates that the Indoor CO_2 Levels shall not exceed 1000 ppm.

DRI
Innovative Air Solutions

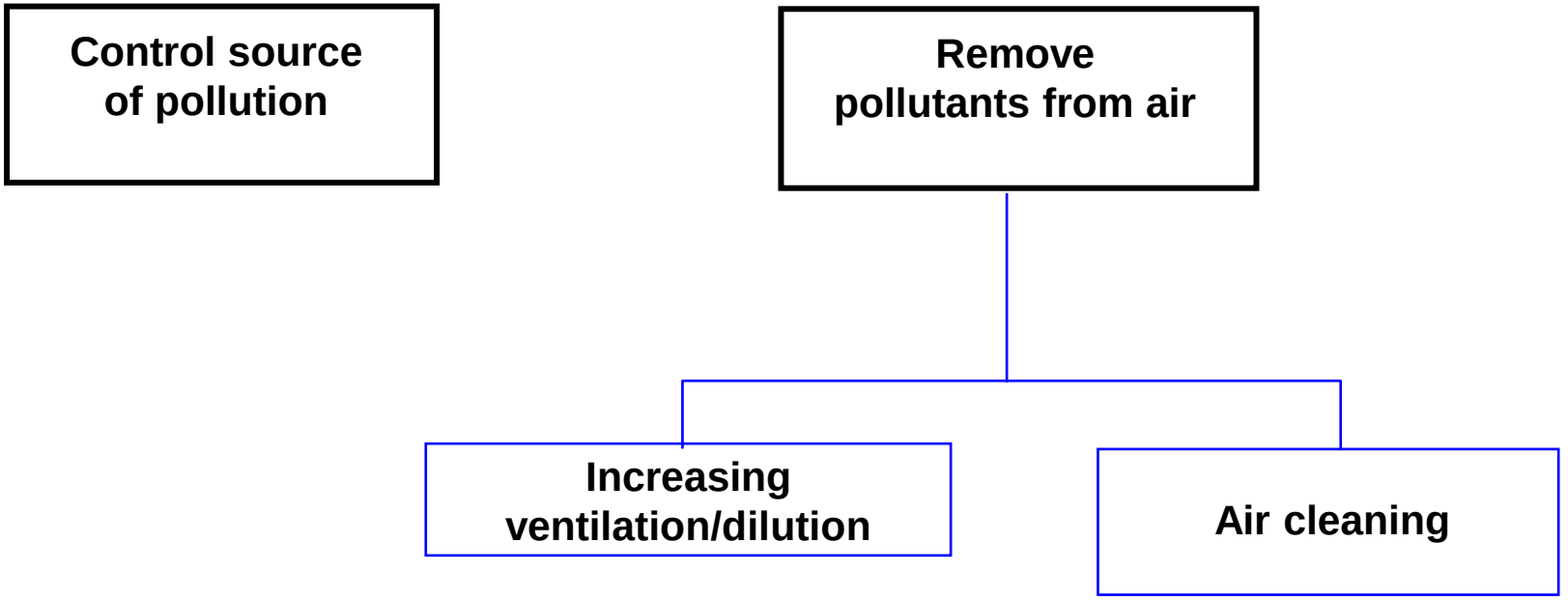
Monitor CO2 levels with……..

ECOFRESH™ CO_2 Sensor

- Self Calibrating and CO_2 concentration is adjustable from 0 to 10,000 ppm
- Microprocessor Controlled
- Low voltage wiring
- Easy to read display
- Handheld, light weight and Compact.
- Highly accurate measurements
- Easy front panel programming
- Selectable CO_2 Setpoint
- System Return Air Duct Mounting option

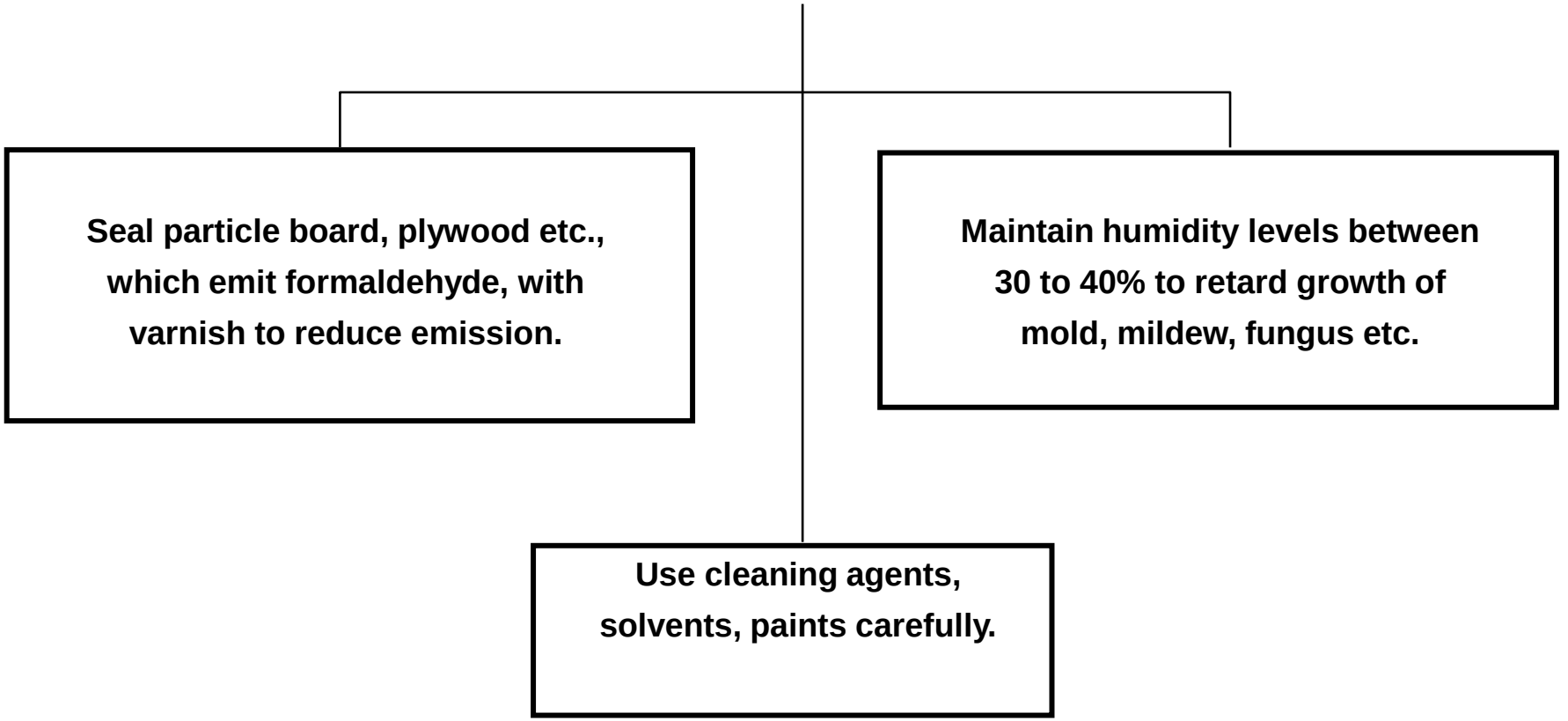
Innovative Air Solutions

Methods to Enhance IAQ
. . . . to reduce Indoor Air Pollution



DRI
Innovative Air Solutions

Source Control Methods



Although, source control is the most effective way of dealing with Indoor Air Quality (IAQ) problem, it is often impractical, expensive and sometimes impossible.

DRI
Innovative Air Solutions

The Solution to Pollution
is Dilution
i.e.
“More Fresh Air … Indoors”

DRI
Innovative Air Solutions

Ventilation

The preferred solution for Indoor Air Quality problems

Ventilation is the movement of air and it's contained pollutants to outdoors and flow of fresh air indoors.

- The flow of fresh air dilutes the concentration of pollutant indoors.
- It is ideal way of keeping indoor air clean.

  However, simple mechanical ventilation increases the fresh air load on conditioning systems resulting increase in tonnage . . . more energy cost.

Indoor Climate and Productivity (Europe)

- ”A minor 1 % (5 min/day) increase in office work can off-set the annual cost of ventilating the building.”
- ”The full costs of installation and running the building can be off-set by productivity gains of just under 10%.”
- ”A reduction of indoor air temperatures by 1 °C can roughly increase the performance of office work by 1% (valid above 22 °C).
- ”Doubling the outdoor air supply rate can reduce sick leave prevalence by 10 %, and increase office work by 1,5%.”

Source: Wargocki, Seppänen: Indoor Climate and productivity in Offices, Rehva guidebook n:o 6, 2006.

DRI
Innovative Air Solutions

Fresh Air Calculation as per ASHRAE 62.1 – 2010

Fresh Air = 5 cfm/person+ 0.06 cfm/ft^2

Suppose the office area is 10000 sq ft and there are 100 persons sitting in that area, so fresh air becomes:

F/A= 100X5+0.06X10000=1100cfm

i.e 11 CFM / person

DRI
Innovative Air Solutions

Ventilation Rates

IAQ generally refers to the quality of the conducted air in an indoor environment. Other terms related to IAQ include **Indoor Environmental Quality (IEQ)** and "**Sick Building Syndrome**".

Application	Ventilation Rate/person	Application	Ventilation Rate/person
Office space	20 cfm	Auditorium	15cfm
Smoking	60 cfm	Conference Rooms	20cfm
Lounge	20 cfm	Classrooms	15cfm
Restaurants	25 cfm	Hospital Rooms	25cfm
Beauty Salon	30 cfm	Laboratory	20cfm
Bars/Cocktail	30 cfm	Operating Rooms	30 cfm
Supermarkets	20 cfm		

IAQ (Ventilation) Standards

- ASHRAE 62.1 and EN 15251 specifies the ventilation rate for office building

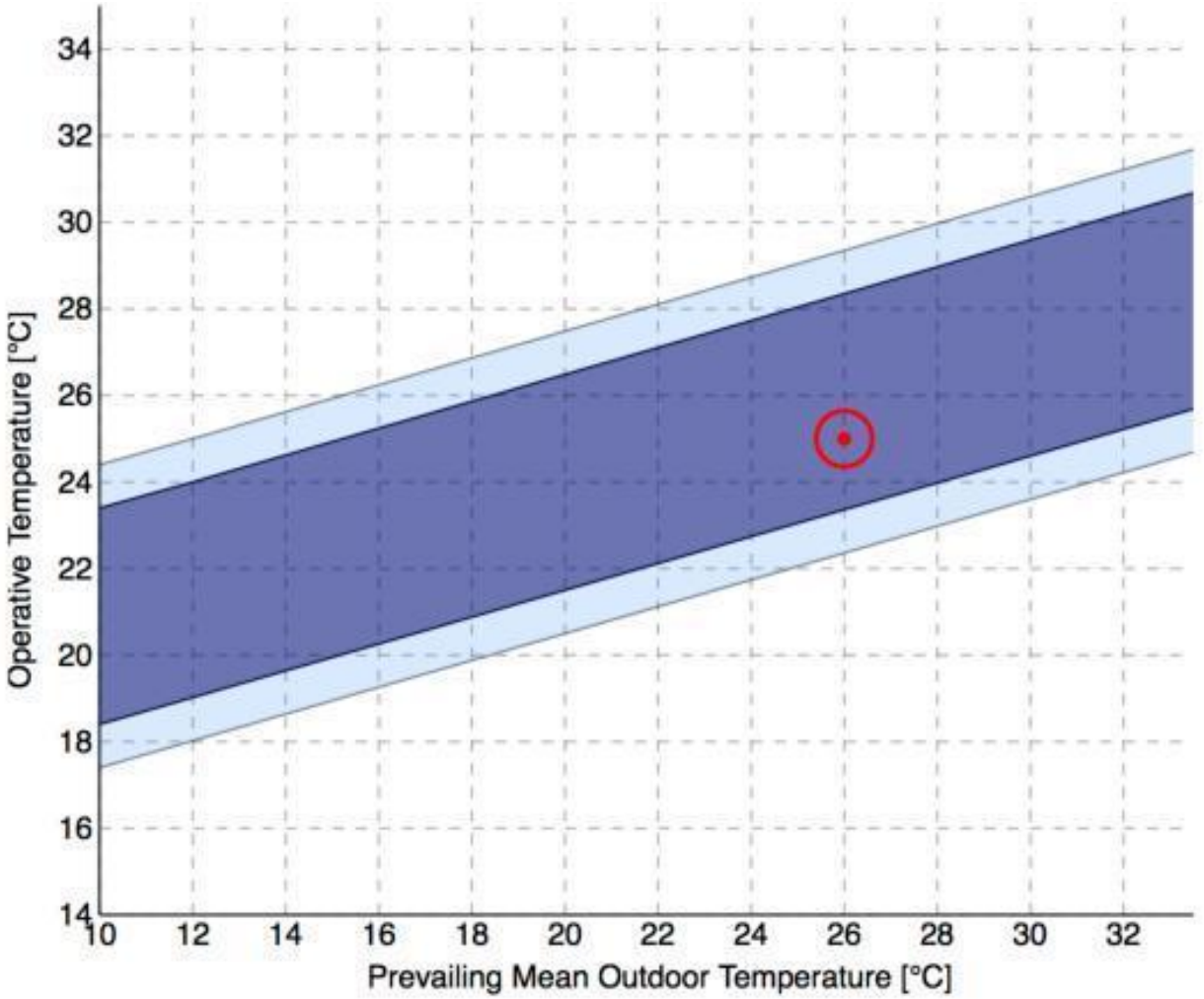
Occupancy	Standards									
	ASHRAE 62.1	EN 15251								
		Category I			Category II			Category III		
Minimum ventilation for occupants in l/s/person (cfm/person)	2,5 (5.3)	10 (21.18)			7 (14.83)			4 (8.47)		
Additional ventilation for building in l/s/m^2 (cfm/ft^2)	0,3 (0.06)	A	B	C	A	B	C	A	B	C
		0,5 (0.1)	1 (0.2)	2 (0.4)	0,35 (0.07)	0,7 (0.14)	1,4 (0.28)	0,3 (0.06)	0,4 (0.08)	0,8 (0.16)

A – Very Low Pollution **B –** Low Pollution **C –** Not Low Pollution

- ASHRAE: (2.5 + 0.3*7)/7 = 0.7 l/s,m^2 (0.13)
- LEED (ASHRAE+30%): 0.7 l/s,m^2 * 1.3 = 0.9 l/s,m^2 (0.17)
- EN Category II, low polluting: (7 + 0.7*7)/7 = 1.7 l/s,m^2 (0.32)

Innovative Air Solutions

Thermal Comfort Standard (ASHRAE 55 – adaptive comfort)



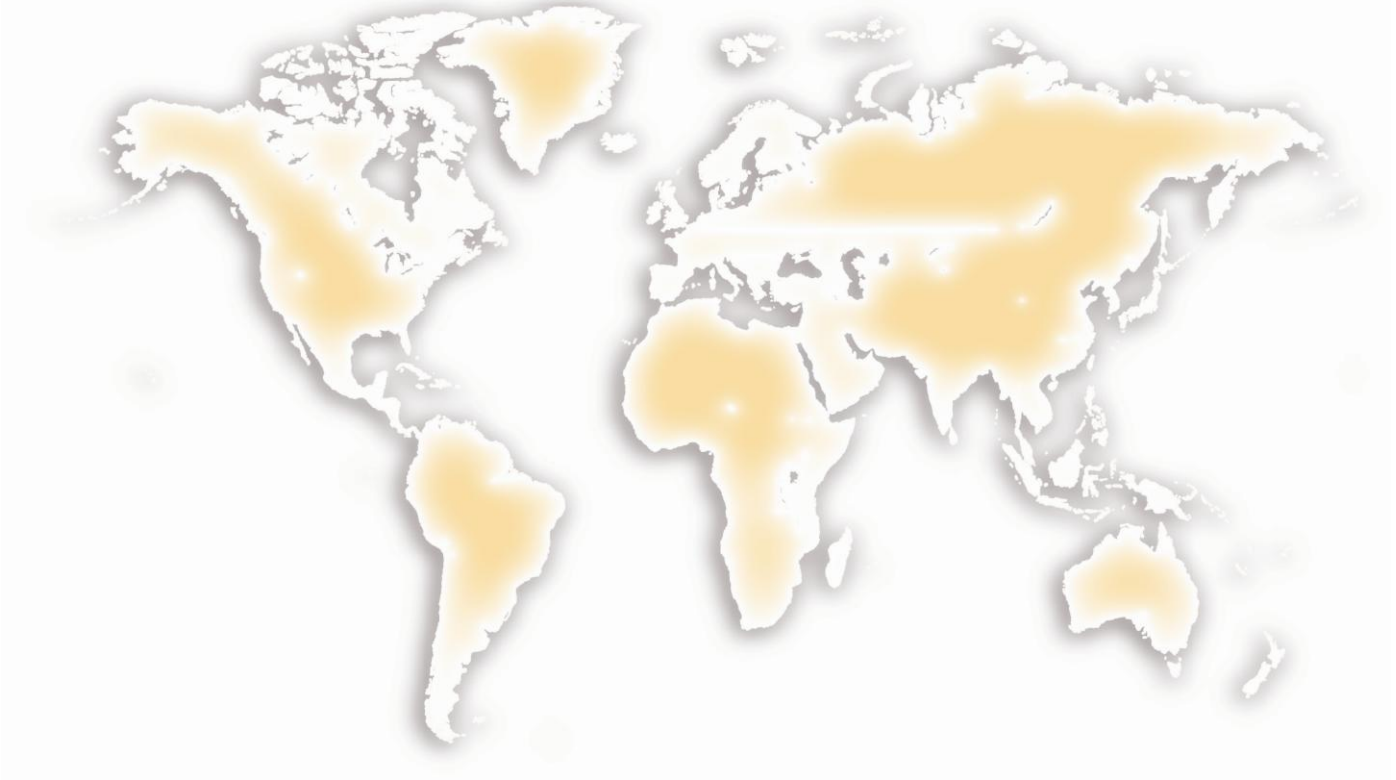
Innovative Air Solutions

The Designer's Dilemma

- Fresh air ventilation runs contrary to the guidelines being followed by HVAC professionals. Higher fresh air ventilation needs translate into higher outdoor air changes per changes, which leads to more air-conditioning loads necessitating installation of higher capacity plants. This leads to higher initial cost and higher energy bills.
- The right humidity levels have to be maintained despite the increased ventilation rates and also to avoid expensive and inefficient solution like re-heat.
- New standards and increased awareness of the effect of IAQ on health necessitates the engineers and building designers conceptualize and provide cost effective solution to indoor air quality requirements.

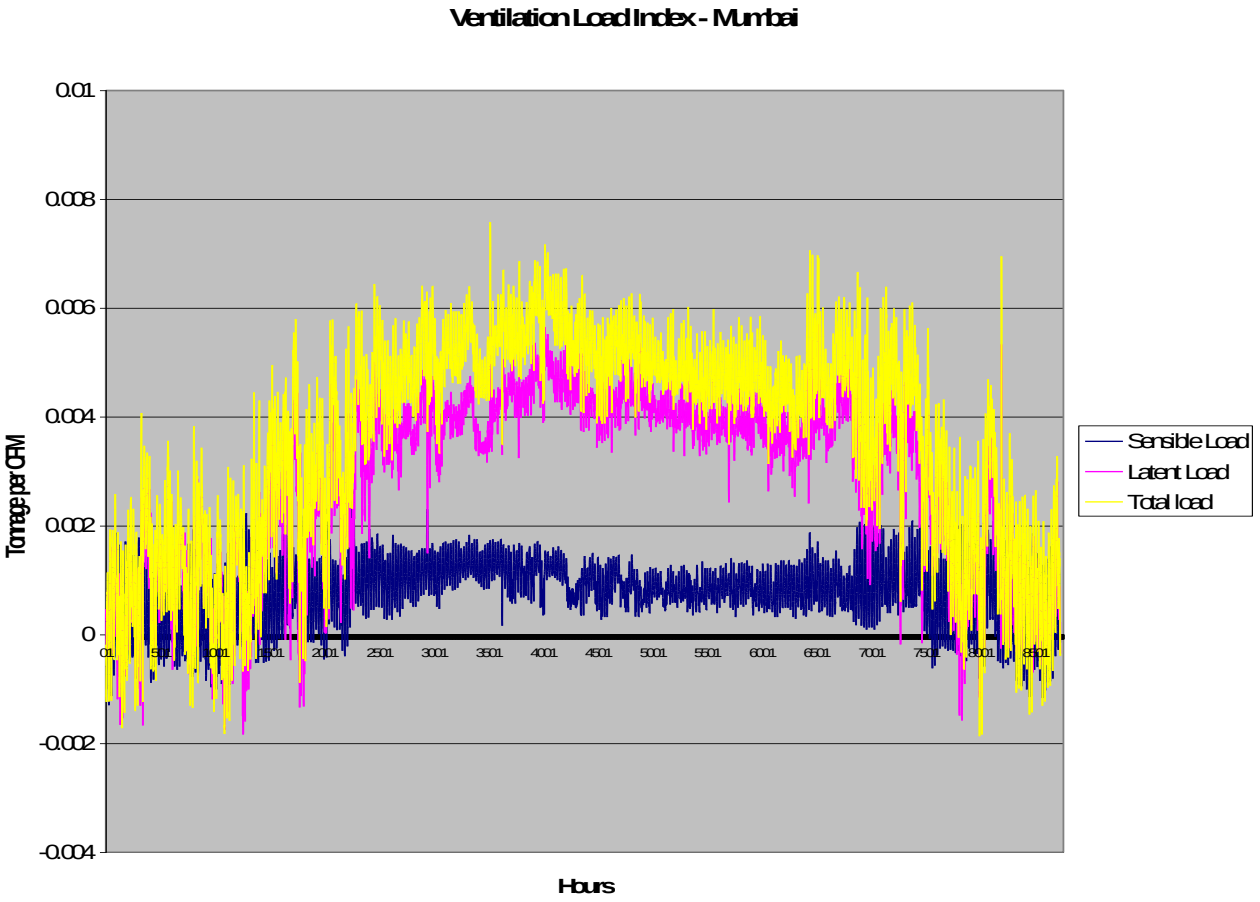
DRI
Innovative Air Solutions

Balancing Ventilation rates for IAQ & HVAC system energy consumption



Europe : Heating Centric Products & Design
North America : Cooling Centric Products & Design
Asia & Brazil : Moisture Centric Products & Design
(HOT & HUMID CLIMATES)

VLI Load Profile



Outside Air load- Mumbai Ventilation Load index Mumbai (for 1000cfm)

Innovative Air Solutions

Solution for Hot & Humid Climates

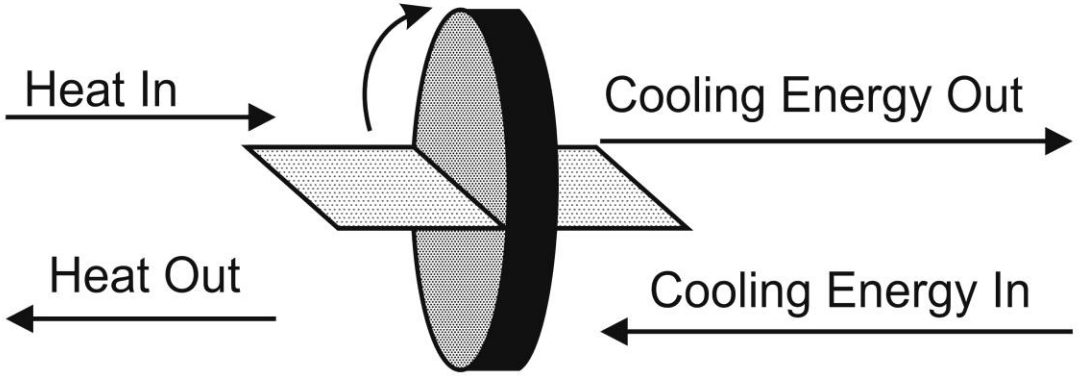
Air to Air Heat Exchangers units which recover total energy from exhaust air & use this energy to pre-cool & dry the fresh air into the buildings.

DRI
Innovative Air Solutions

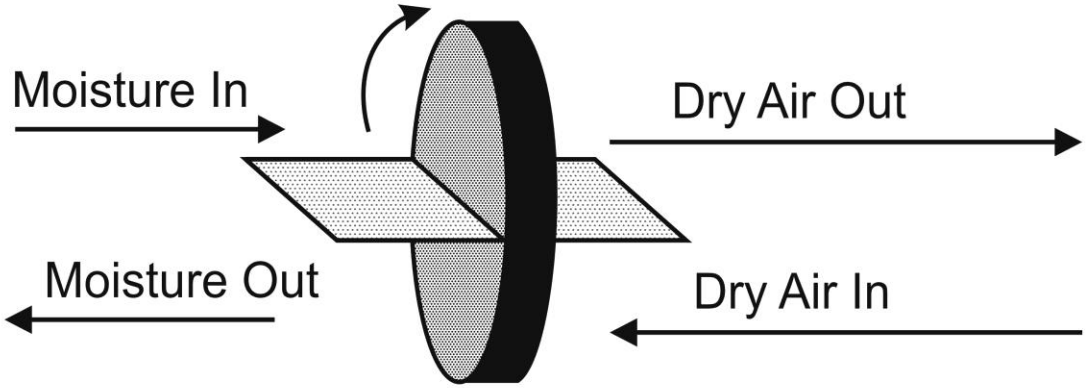
Total Energy Recovery Wheels

Universal Rules of Total Energy Wheels

1. Heating/Cooling Energy (e.g. 80%) Is Always Returned To Where It Came From

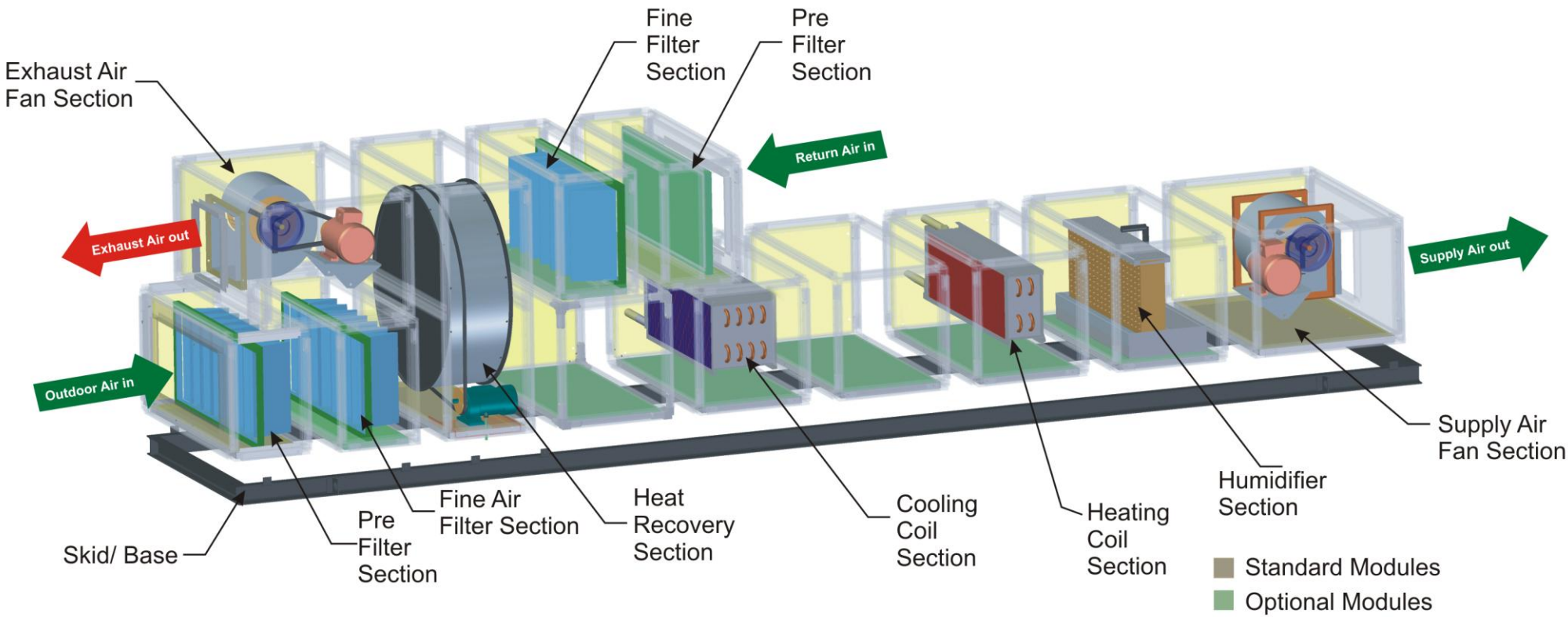


2. Moisture and Dry Air (e.g. 80%) Is Always Returned To Where It Came From



DRI
Innovative Air Solutions

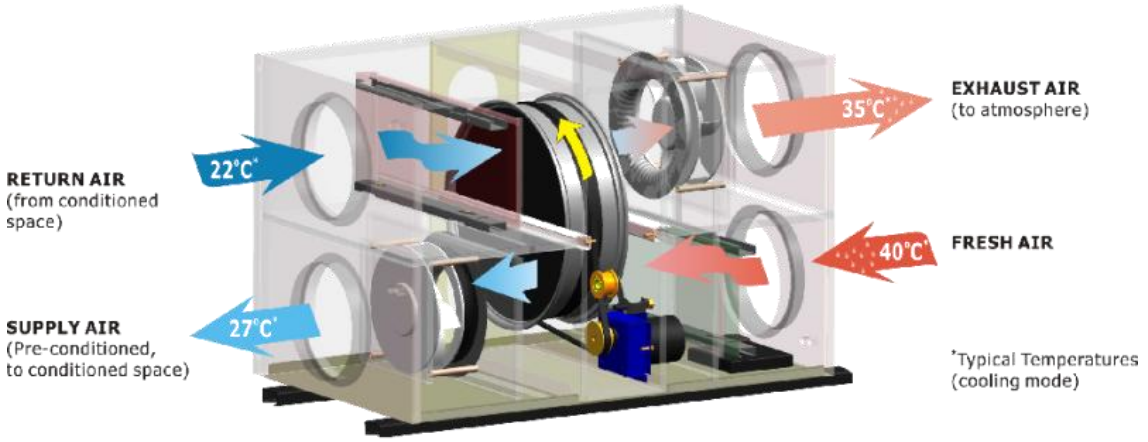
UNIT ASSEMBLY



Innovative Air Solutions

Design your Air with

Energy Recovery Ventilators (ERVs) for Fresh & Healthier 'In'vironment



SOLUTION TO POLLUTION IS DILUTION
Redesign or Maintain Your IAQ (Indoor Air Quality) with

Maintaining IAQ in


BPOs / Call Centers / Office Buildings


Conference / Meeting Rooms


Hospitals / Healthcare facilities


Schools / Institutions


Supermarkets / Retail Stores


Restaurants / Bars / Discotheques


Gymnasiums / Recreation Centres


Movie Theatres / Auditoriums

. . . And all other air-conditioned spaces !


DRI
Innovative Air Solutions
Air pollution at critical level in parts of city: Centre for Science and Environment
DELHI IS INDIA'S ASTHMA CAPITAL
Capital's children in harm's way
Shanghai Daily
WHO ready to help as China's H7N9 toll rises
184
Unhealthy
CHINA
Government sets targets for control of pollution
Mumbai new pollution capital
Delhi air and water in a dismal state
POLLUTION CHOKING DELHI
Delhi air worst in the world
Packed With Fine Particles That Damage Heart, Lungs: WHO
Air pollution is choking Delhi skies
CAPITAL BREATHES UNEASY
Mumbai to get air quality monitoring station soon
HORN NOT OK PLEASE
Delhi in the News!
DRIAPS
www.drirotors.com
30

Outdoor Air Pollution 101

- Particulate Contamination
- Gaseous Contamintion

- **Solids (Particulates) – 0.003 to 100 microns**

Dust   Smoke

- **Liquids (& Vapours) – 1 to 9 microns**

Vapours   Aerosols

- **Gases – 0.0003 to 0.007 microns**

Sulphur Oxides (Sox)

Nitrogen Oxides (NOx)

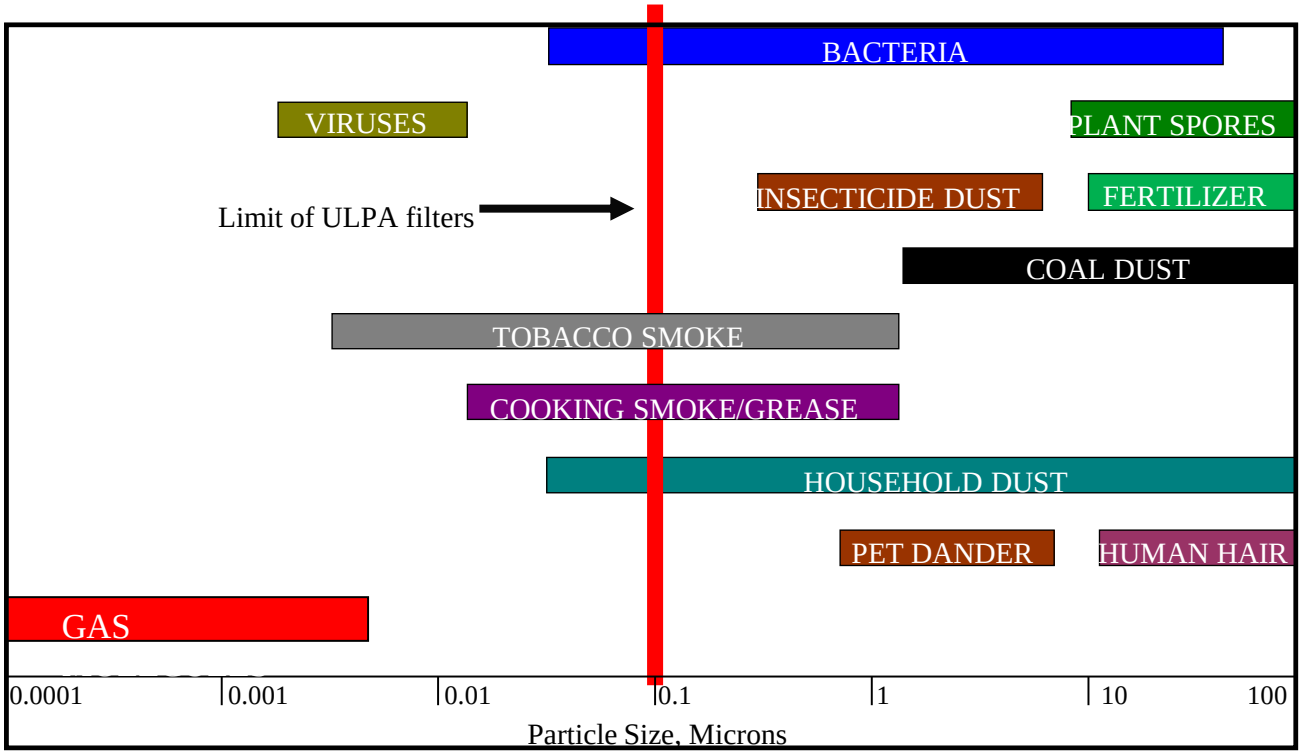
Formaldehyde (HCHO)

Chlorine (Cl2)

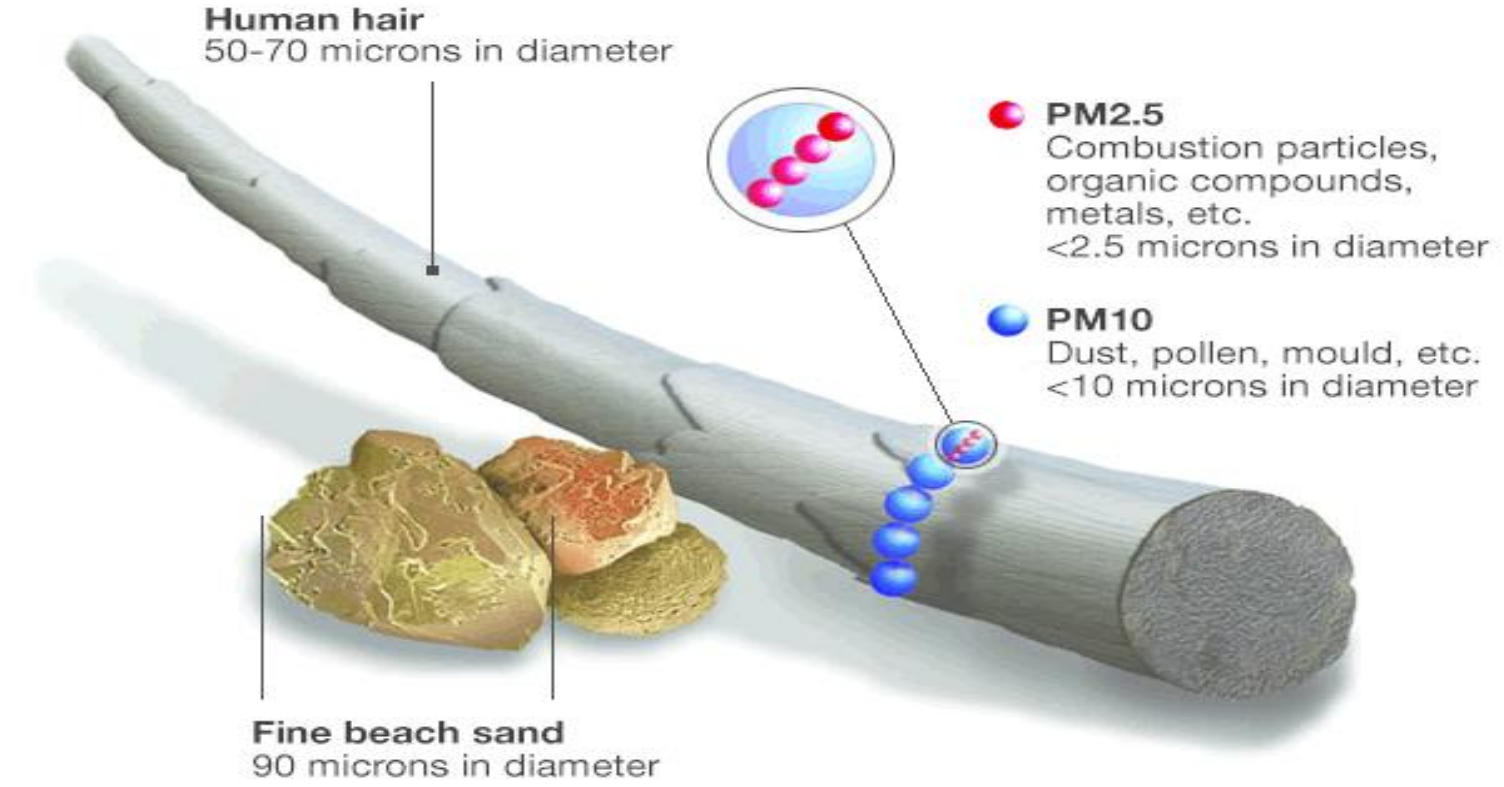
Hydrogen Sulphide (H2S) *… etc.*

Particulates vs. Gaseous Contaminants

Innovative Air Solutions



What is Particulate Contamination (PM 2.5)



Source: US EPA

Sources of Particulate Contamination

- Vehicles (Predominantly Diesel)
- Thermal Power Plants
- Open Fire Cooking (Chullahs)
- Stubble Burning
- Burning of Wastes
- Industrial Process Emmissions

Sources of Gaseous Contamination

- Vehicles

- Open Sewage System

- Industrial Processes

Acceptable Levels

Particulate matter (PM2.5) 24 h mean	< 25 µg/m3	WHO Air Quality Guideline
Particulate matter (PM10) 24 h mean:	< 50 µg/m3	WHO Air Quality Guideline
Carbon dioxide (CO_2)	< 1000 ppm	ASHRAE 62.1-2013
Sulphur dioxide (SO_2) 24 h mean	< 20 µg/m3	WHO Air Quality Guideline
Nitrogen dioxide ($NO_{2)}$ 1 h mean	< 200 µg/m3	WHO Air Quality Guideline
Ozone (O_3) 8 h mean	< 100 µg/m3	WHO Air Quality Guideline
Carbon monoxide (CO) 8 h mean	<75 ppm	ASHRAE 62.1-2013
Formaldehyde	<0.1 mg/m3	ASHRAE 62.1-2013

Innovative Air Solutions

Health Effects of Higher Pollution Levels

Particulate Contamination

- Increasing respiratory symptoms, e.g. irritation of the airways, coughing, or difficulty in breathing;
- Decreasing lung function;
- Aggravation of asthma;
- Development of chronic bronchitis;
- Adverse effects on the cardiovascular system; and
- Premature death of people with heart or lung diseases.

Health Effects of Higher Pollution Levels

Gaseous Contamination

SOx :

- Irritates the throat and lungs;
- If there are fine dust particles in the air, it can damage a person's respiratory system; and
- If combined with other substances in the air, it produces a haze that reduces visibility.

NOx :

- Increased incidence of respiratory illness,
- Increased airway resistance (due to inflammation),
- Damage to lung tissue,
- Chronic obstructive pulmonary disease or COPD (narrowing of the airways),
- Emphysema (as part of COPD),
- Pulmonary edema (accumulation of excessive fluid in the lungs),
- Infant and cardiovascular death.

Points to ponder

- Reducing Outdoor Air Pollution is not necessarily in our control – dependent on multiple factors / agencies

- Indoor Air Pollution is what we can control and it is the Indoors where we spend most of the times – Residences / Offices / Schools / Malls / Hotels

Designer's Dilemma

- World Wide fresh outdoor air is brought in to improve Indoor Air Quality as per established ventilation rates.
- The guidance on these ventilation rates is practised based on ASHRAE / European Standard (EN 15251) / Local Codes.
- These ventilation rates guidelines have evolved over the last few decades and have been decided after years of research, implementation and feedback.
- In cities like Delhi and Beijing the dilemma is that the Outdoor Air Quality itself is bad.

Hence, the Outdoor Air has to be properly cleaned before being introduced in the occupied spaces to achieve the following:

- Dilute the Indoor Contaminants built up and exhaust the same
- Maintain the building under positive pressurization to prevent any infiltration
- Remove the Particulate and Gaseous Contaminants

Particulate Filtration

- Typically Particulate Filtration Stages can be classified as:

- Primary Filtration (G1 – G4 as per EN – 779 or MERV 1 – 8 as per ASHRAE 52.2)
- Secondary Filtration (M5 – M6 & F7 – F9 or MERV 9 – 15)
- Another class of filtration is HEPA (High Efficiency Particulate Air Filters) and ULPA (Ultra Low Penetration Air Filters) which are generally used in Clean Rooms / Hospitals and Manufacturing Areas.

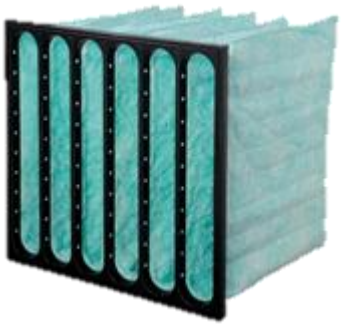
Particulate Filtration

EU 2 Washable

EU 3-4 Washable

EU 3-5 Washable

EU 3 Bag Filter



EU 5-9 Bag Filters

EU 5-8 Box Filter

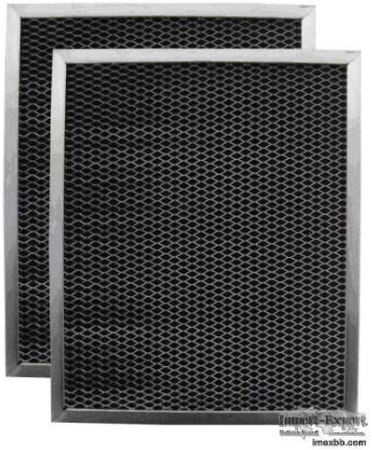
HEPA/ULPA Filter

Gas Phase Filtration

The process of removing harmful gases is done by adsorbing these gases on an adsorbent and neutralizing / oxidising them by treating with a suitable chemical.

- The process is specific and depends on the chemical nature of both the media and gas.
- The process is instantaneous and irreversible.
- Changes harmful gases to harmless solids.
- The Phenomena is called Chemisorption

Gas Phase Filters



Odor Filters

Gas Phase Filters

DRI

Innovative Air Solutions

Stand Alone Room Air Purifier

Central Ducted Air Purification System

DRI
Innovative Air Solutions

FEW IAQ UNITS

DRI
Innovative Air Solutions

AIR PURIFICATION SYSTEMS – HCL OFFICE BUILDING

DRI
Innovative Air Solutions

AIR PURIFICATION SYSTEMS – HCL OFFICE BUILDING

AIR PURIFICATION SYSTEM – LEADING INTERNATIONAL SCHOOL

Innovative Air Solutions

AIR PURIFICATION SYSTEM – LEADING INTERNATIONAL SCHOOL

DRI
Innovative Air Solutions

CHEMICAL FILTER UNIT

DRI
Innovative Air Solutions

DRI
Innovative Air Solutions

THANK YOU