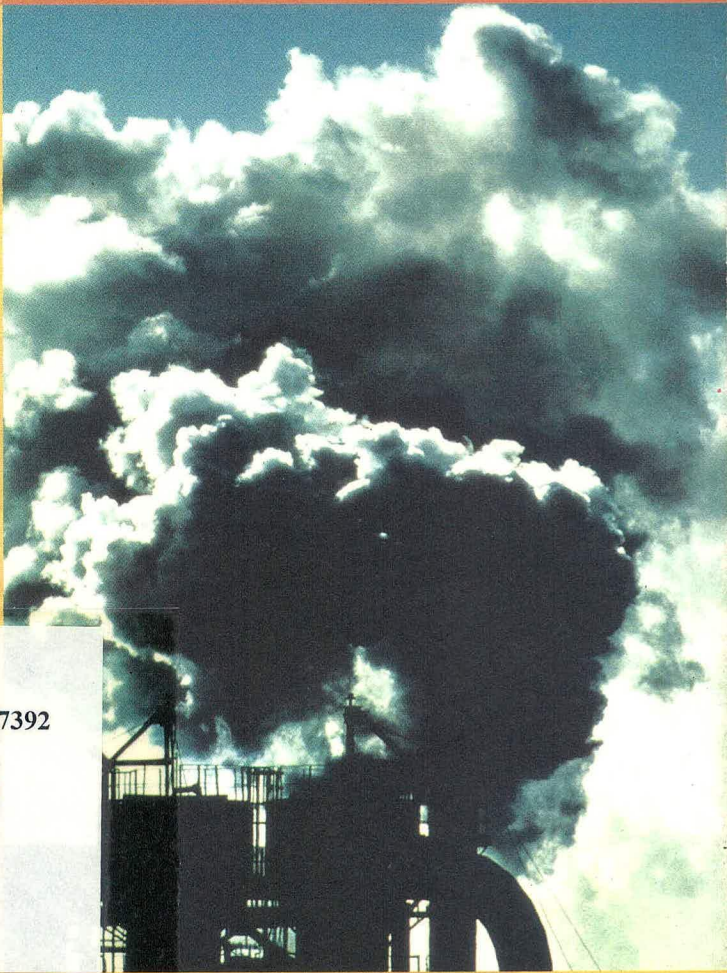


HANDBOOK FOR LEGISLATORS

A GUIDE TO  
**Air Pollution**



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Environmental Quality Council

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A GUIDE to air pollution : handbook for legislators /  
Environmental Quality Council.

A GUIDE TO  
**Air Pollution**

CONTROL NUMBER	0000019327
ACCESSION NUMBER	26277/HQ.
DATE	18-2-2008

Environmental Quality Council  
November 2003

*Dengan Ingatan Yang Tulus Ikhlas*  
daripada  
Ketua Pengarah  
Jabatan Alam Sekitar  
Malaysia

HANDBOOK FOR LEGISLATORS

## Minister's Message

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The Environmental Quality Council, EQC has taken the initiative to put together basic scientific ideas, environmental terms and concepts for legislators in the form of a Handbook.

The Handbook consists information on the most important components of the environment, i.e.; air and water, which will help decision-makers formulate new strategies and plan of action to stimulate more awareness on the environment among Malaysians so that the country can move forward in its endeavours to realize the goals of Vision 2020.

In essence, this Handbook will provide informative guidance on environmental issues in order that the environment will remain clean, safe, healthy and productive. This would further strengthen our effort to achieve sustainable development in the most optimal manner.

My congratulation and sincere appreciation to the EQC members, the Department of Environment and all others involved for their commendable initiative towards the betterment of the environment.

A handwritten signature in black ink, appearing to read 'Law Hieng Ding', written in a cursive style.

**Dato' Seri Law Hieng Ding**  
Minister of Science, Technology and Environment  
Malaysia

## Chairman's Statement



There is so much to do for the environment; yet those of us who are often legally responsible for making decisions that affect the environment know so little about it. And this is what this book is about - a handbook to guide what is and what is not to be done when confronted with an environmental concern or problem.

The Environmental Quality Council is a statutory body created under the Environmental Quality Act of 1974. Its function is to advise the Minister concerned with the environment on all matters coming within the preview of the Act (see <http://www.jas.sains.my/doe/eqcqc.htm>). Hence, it involves itself in debating on what are the proper approaches and action to be taken to conserve and protect and at times to improve the quality of the environment. Often, the debate involves environmental policies to be pursued and this includes the substance laws and regulations should have and the form they must take to achieve the betterment of the environment.

Members of the Council lament the often unnecessary and avoidable problems caused by a misunderstanding, from the environmental viewpoint, of two most essential components of the environment - air and water. Good quality air and water are necessary to good health and safety. It is our fervent hope that this handbook to guide decision-makers will fill a gap so sorely needed.

A handwritten signature in black ink, appearing to be 'Dato' Kok Wee Kiat', written over a light-colored background.

Dato' Kok Wee Kiat

A.M.N., Dato' Seri Ketam (Sel), O.M.R.I. (Italy), O.B.O.H. (Chile), LL.B (Hons)(Sing)

Chairman

Environmental Quality Council Malaysia

November, 2003

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## Why Air Is Important to Us?

### Human Daily Intake

Air = 10.25 kg  
Water = 1.30 kg  
Food = 1.20 kg

### Length of Time Sustained Without

Air = A few minutes  
Water = A few days  
Food = A few weeks

## Definition

Air pollution is defined as the transfer of harmful amounts of natural and synthetic materials into the atmosphere as direct or indirect consequence of human activity.

*Kupchella and Hyland (1993)*

## What is Air Pollution

".....are airborne particles and gases that occur in concentrations that endanger the health and well-being of organisms or disrupt the orderly functioning of the environment."

### Interpretation Under Environmental Quality Act 1974

"Pollution" means any direct or indirect alteration of the physical, thermal, chemical, or biological, properties of any part of the environment by discharging, emitting, or depositing environmentally hazardous substances, pollutants or wastes so as to affect any beneficial use adversely, to cause a condition which is hazardous or potentially hazardous to public health, safety, or welfare, or to animals, birds, wildlife, fish or aquatic life, or to plants or to cause a contravention of any condition, limitation, or restriction to which a license under this Act is subject.

"Pollutants" means any natural or artificial substance, whether in a solid, semisolid or liquid form, or in the form of gas or vapour, or in a mixture of at least two of these substances, or any objectionable odour or noise or heat emitted, discharged or deposited or is likely to be emitted, discharged or deposited from any source which can directly or indirectly cause pollution and includes any environmentally hazardous substances.

**A Brief  
Historical  
Perspective**

## A Brief Historical Perspective

### Major Air Pollution Disaster

International:

- **December 1930**

Venue : Meuse Valley of Belgium.

Episode : Killing 63 people and causing 6000 to become ill.

Cause : A mysterious irritating fog originated from some unknown gas, perhaps left over of World War I.

- **1947**

Venue : Los Angeles

Episode : During smoke attacks, the ozone of the LA air reaches a level 10 to 20 times higher than elsewhere.

- **October 1948**

Venue : Donors, Pennsylvania.

Episode : Killing 20 people and almost 6000 of the town's 14,000 inhabitant became ill.

Cause : Resulted from a combination of mountainous terrain surrounding the valley and stable weather conditions that trapped and concentrated deadly pollutants emitted by the community's steel mill, zinc smelter and sulfuric acid plant.

- **December 1952**

Venue : London, England

Episode : More than 4000 people died as a result of this 5-day ordeal.

Cause : A highly synergistic combination of water vapor, CO, SO<sub>2</sub> and tar.

## National:

### • September 1997

- ▶ The severe and extended drought from June to September 1997 in southern Sumatra and Kalimantan caused the biomass burning.
- ▶ The Smoke particulates from the forest fires were transported to Sarawak.

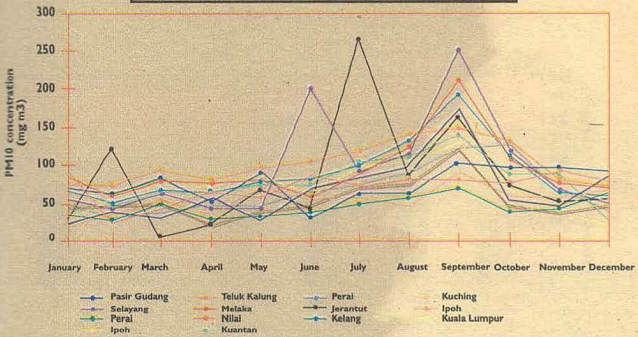
API =



Air Pollutant Index (API) shot up to an unprecedented level of 839 in Kuching on September 23, 1997 at 11 a.m

- ▶ A 10-days state of emergency was declared in Sarawak state on September 19, 1997.

Monthly PM<sub>10</sub> concentration in 1997 in Malaysia



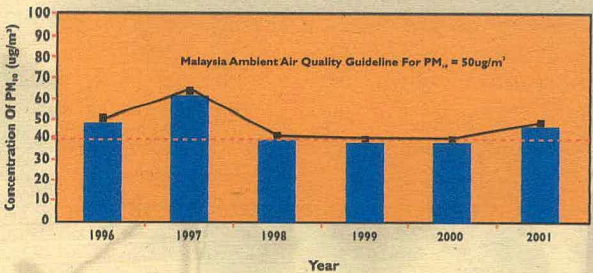
The figure shows that the concentration of particulate matter (PM<sub>10</sub>) in most of the monitoring stations achieved peak value during the haze episode in September 1997.

## Some Facts About Haze

- ▶ About 20% of the haze in Kuala Lumpur in 1997 caused by local pollution and about 80% of the haze is mainly caused by forest fires.
- ▶ Most of the local pollutants were emissions from vehicles and factories.
- ▶ The previous haze problem in the city in 1991 showed the 60% of the pollutants were from forest fires.
- ▶ The contents in the haze comprised mainly of sulphur, potassium, magnesium and organic matter.
- ▶ ".... Nothing can be done about the haze situation unless the forest fires are put out...." said a scientist from UPM during haze episode 1997.

### Particulate Emissions in Malaysia

Malaysia: Annual Average Particulates Matter (PM<sub>10</sub>) Concentration, 1996-2001



This Figure presents the long-term trends in particulate emissions from 1985 through 1995 that were monitored in Kuching, Kuala Lumpur, Ipoh, George Town and Johor Bahru.

# Source and Types of Air Pollution

Natural

Man-Made

Stationary

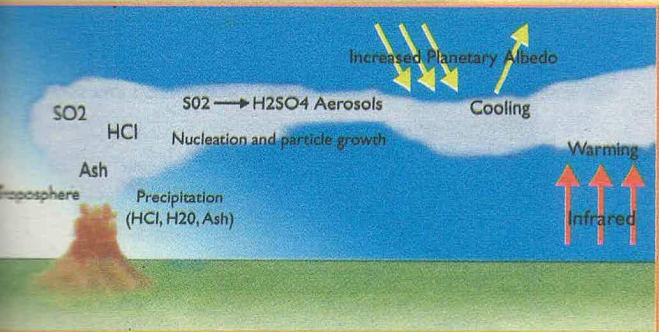
Mobile

## Natural Source

### ► Volcanic Eruption



Eruption of Mount Pinatubo in Philippines at 1991



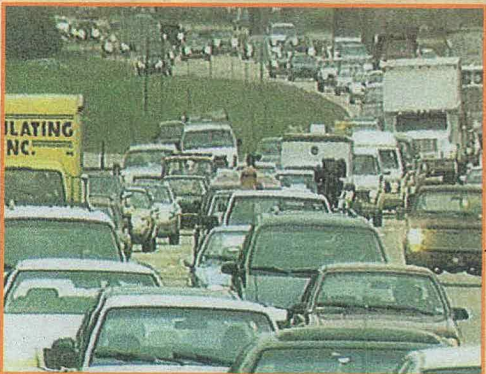
- ▶ Caused by lightning and dry seasons



## Man-Made Source

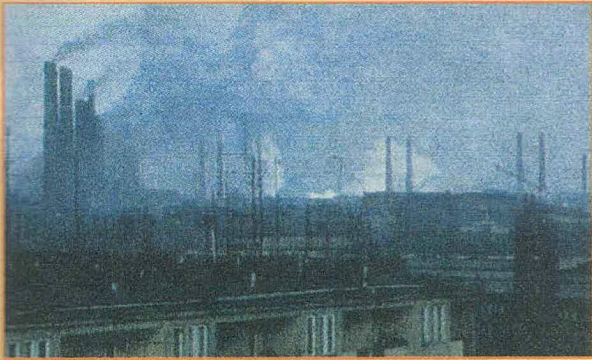
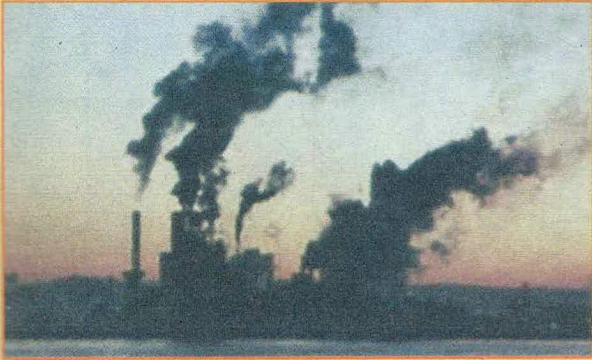
- ▶ Vehicles Emission

- Generates air pollutants such as Carbon Dioxide ( $\text{CO}_2$ ), Carbon monoxide (CO), Oxides of Sulphur ( $\text{SO}_x$ ), Oxides of Nitrogen ( $\text{NO}_x$ ), etc



## ► Industrial Emission

- Emit most of the major pollutants.



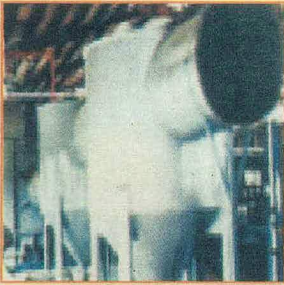
## Other Activities

Approximately 60% of the total emission of  $\text{CH}_4$  (methane) is estimated to be associated with anthropogenic factors such as rice field, dumpsites, biomass burning and animal wastes.

Pollutants may be grouped into 2 categories :

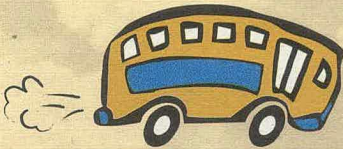
- Primary Pollutants
- Secondary Pollutants

## ▶ Primary Pollutants



- Are emitted directly from identifiable sources.
- They pollute the air immediately upon being emitted.

## ▶ Secondary Pollutants



Sulfuric Acid  
( $H_2SO_4$ )

Proxy Acetyl  
Nitrate (PAN)



Ozone  
( $O_3$ )

- Are not emitted directly into air, but form in the atmosphere when reactions take place among primary pollutants.

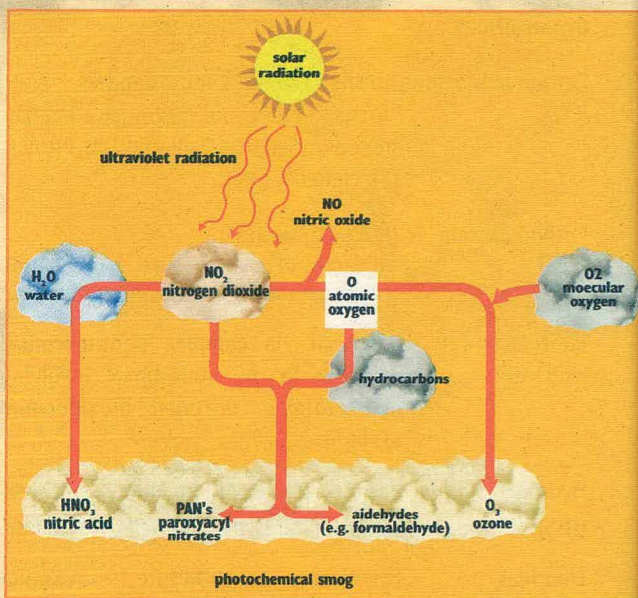
## Source of Major Air Pollutants

Sulphur dioxide (SO <sub>2</sub> )	Combustion of coal, oil and other sulphur containing fuels, petroleum refining, metal smelting, paper making.
Particulate matter	Fuel combustion, industrial processes, construction, forest fire, refuse incineration, automobiles traffic.
Nitrogen dioxide (NO <sub>2</sub> )	Produced by combinations of atmospheric nitrogen and oxygen at high combustion temperatures such as those in automobiles engines, also by product in the manufacturing of fertilizer.
Volatile organic compound (VOC) e.g. Volatile hydrocarbons	Motor vehicles-evaporation from gasoline tanks and carburettor's; industrial processes involving solvents.
Carbon monoxide (CO)	Internal combustion engines, blast furnaces of steel industry, space heaters, improperly adjusted oil and gas burners and charcoal grills.
Carbon dioxide (CO <sub>2</sub> )	$2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$ Emission of fossil fuel combustion, cement production and biomass burning.
Photochemical oxidants	Produced via complex photochemical reactions in the atmosphere involving hydrocarbons, nitrogen dioxide and sunlight.
Hydrogen sulfide (H <sub>2</sub> S)	Various processes in many kinds of chemical industries; oil wells, refineries.
Fluorides	Fertilizer manufacture, ceramics manufacturing, aluminium smelting.
Lead (Pb)	Combustion of lead gasoline; solder; lead containing paint; lead smelting operations.
Mercury (Hg)	Paper, chemical, paint manufacturing; pesticides; fungicides.

## Photochemical Smog

- ▶ is a mixture of primary and secondary pollutants that forms when some of primary pollutants interact under the influence of sunlight.
- ▶ is happening in all modern cities, but it is much more common in cities with sunny, warm, dry climates and lots of motor vehicles.
- ▶  $O_3$  - is secondary pollutant resulting from photochemical reactions. The reactions require oxides of nitrogen, non-methane hydrocarbons and ultraviolet.
  - a highly reactive gas that harms most of living organisms.
- ▶  $NO$  - Nitrogen oxides are key ingredients needed to form photochemical smog.

### Formation of Photochemical Smog



## Natural Gas

- ▶ Large quantities of energy are wasted when natural gas found with oil is burned off, as in Middle East oil field, often referred as 'flaring'.
- ▶ This is done because the cost of collecting and using the natural gas is more than the price it can be sold for in the oil-rich Middle East.
- ▶ Burning this high-quality fuel adds carbon dioxide and other pollutants to the atmosphere, but burning causes less projected global warming than allowing the methane to escape into the atmosphere.
- ▶ Methane ( $\text{CH}_4$ ) reacts with OH radicals,  $\text{O}_2$  and sunlight to form  $\text{CO}_2$ .

## What Factors Affect Air Pollution Levels?

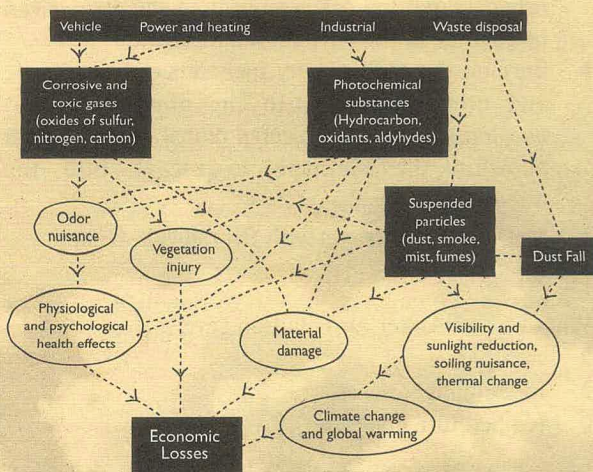
- ▶ Weather
- ▶ Topography
- ▶ Temperature inversion

Dispersion of Atmospheric Pollutants is very much influenced by:

- ▶ Transporting layer of atmosphere from its source to the receptor and the concentration of the transport air pollutants at the receptor dependent on meteorological characteristics of the transporting layer of the atmosphere;
- ▶ Several phase of pollutants transportation and dispersion:
  - Source emission characteristic-initial dilution and plume rise;
  - Dilution by eddy diffusion in proportion to the atmospheric turbulence-field during travel with the average wind-field.
- ▶ Long-range transport out of the local area accompanied by air-mass contamination and dilution due to eddy diffusion and wind-shear effects between pollutants-carrying layers;
- ▶ Atmospheric reaction of the pollutants in the plume to form secondary pollutant compounds and to alter pollutant concentrations
- ▶ Precipitation scavenging processes that alter precipitation formation and cloud droplet chemistry
- ▶ Dry deposition-scavenging processes that remove pollutants from the atmosphere to the Earth's surface.

# Effects of Air Pollutions

## Possible Pathways

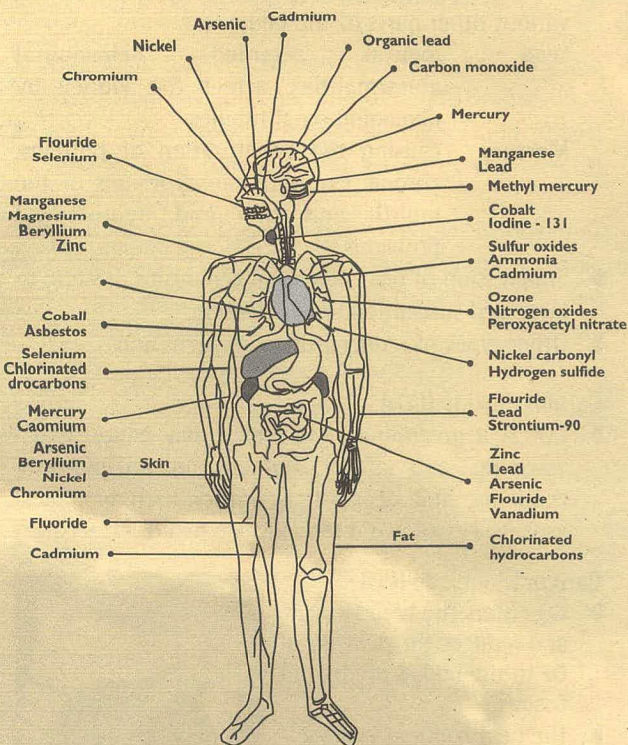


- ▶ "There is poison in everything and no thing is without poison. It is the dose that makes it harmful or not".

*Paracelus (1493-1541)*

- ▶ Chronic and acute effects.
- ▶ There are 4 factors that influence how a toxic substance will affect an individual:
  - Concentration
  - Duration of Exposure
  - Toxicity
  - Individual susceptibility

## Effects on human health



## Main targets of major air pollutants in the human body

Classification of diseases related to the general problem of community exposure to air contaminants:

- ▶ Pulmonary irritation and acute impairment of lung function (breathing)
- ▶ Cancer: carcinogens which are able to react with DNA to cause cancer; e.g.  $O_3$ .
- ▶ Structural changes in lungs; e.g. silicosis, anthracosis  
dust in the lung causes a response in which fibrous tissue is deposited around dust particles, creating "macules".

- ▶ Systemic toxicity: air pollutants that get into the bloodstream via the lungs may cause problems in various other parts of the body; e.g.
  - Lead : mental retarded, behavioural abnormalities, affect the kidney by damaging renal tubules.
  - Mercury : causing the denaturation of proteins, chronic exposure causes lesions of the mouth and skin and neurological problems.
- ▶ Suppression of host defense mechanisms, leading to increased susceptibility to infection.
- ▶ Other types of reduced tissue oxygenation.

### Carbon dioxide (CO<sub>2</sub>)

- ▶ CO<sub>2</sub> is a greenhouse gas which may cause global warming and affect humans in sociological, economic and geopolitical, rather than biological aspects. No known direct adverse health effects.

### Carbon Monoxide (CO)

- ▶ CO enters the bloodstream and reduces the delivery of O<sub>2</sub> to the body's organ and tissues.
- ▶ The health threat is most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease.
- ▶ Exposure to elevated CO levels is associated with impairment of visual perception, manual dexterity, learning ability, and performance of complex tasks.



### Ozone (O<sub>3</sub>)

- ▶ Ground-level ozone (O<sub>3</sub>) is the major component of smog.
- ▶ Upper atmospheric O<sub>3</sub> benefits life by shielding the earth from the sun's harmful ultraviolet radiation.
- ▶ High ozone concentration damages lung tissue, reduces lung function, and sensitizes the lung to other irritants.
- ▶ O<sub>3</sub> is formed through complex chemical reactions between precursors emissions of volatile organic compounds (VOC) and nitrogen oxides (NO<sub>x</sub>) in the presence of sunlight.

### Sulfur oxide (SO<sub>x</sub>)

- ▶ Children, elderly, asthmatics and allergy sufferers at greatest risk.
- ▶ Irritates nose, nasopharynx and bronchi; increases likelihood of lung cancer.
- ▶ Aggravates heart and lung disease, obstructs breathing.
- ▶ Causes headaches, coughing, throat irritation.
- ▶ Associated with premature death.

### Hydrocarbons (HC) {e.g. benzene, terpene}

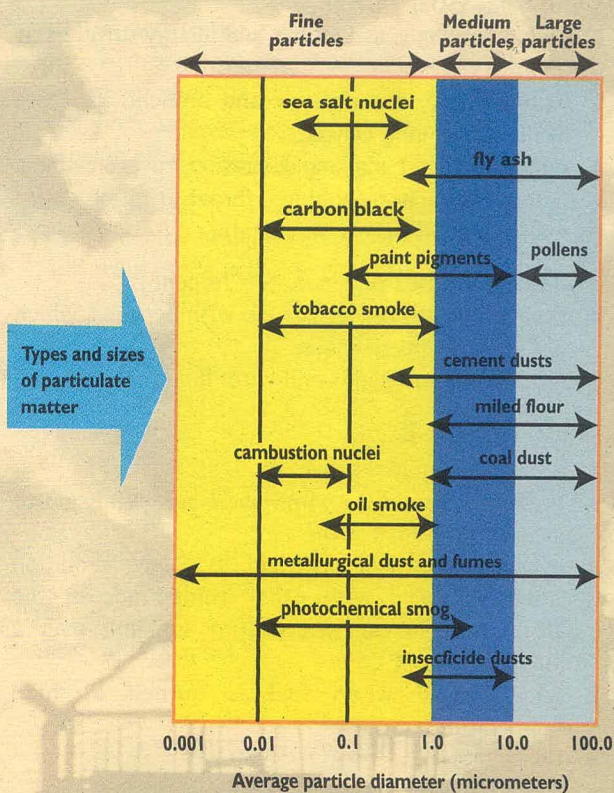
- ▶ Greatest health risk associated with benzene, which is a suspected carcinogen.
- ▶ Adhere to particulates and enter lungs.

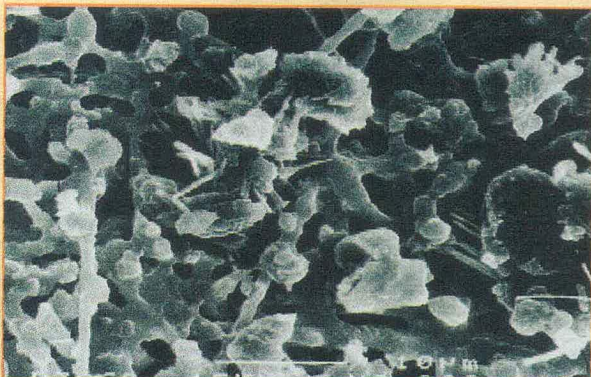
### Nitrogen dioxide (NO<sub>2</sub>)

- ▶ Brownish, highly reactive gas
- ▶ NO<sub>2</sub> is formed in the atmosphere from emission of oxides of nitrogen (NO<sub>x</sub>)
- ▶ NO<sub>x</sub> is a precursor pollutant to ozone formation when it reacts with other compounds in the atmosphere in the presence of sunlight, over a longer period of time.
- ▶ NO<sub>x</sub> formed when fuel is burned at high temperatures.
- ▶ Two sources:
  - transportation (primarily motor vehicles)
  - stationary fuel combustion (e.g. electric utilities)
- ▶ Nitrogen dioxide can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections.
- ▶ Nitrogen oxides are important precursors to both ozone and acidic precipitation.

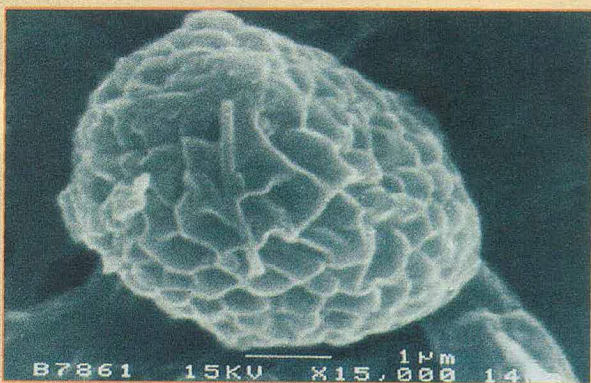
## Particulates

- ▶ Have greatest effect on children, the elderly and those with chronic obstructive pulmonary disease, cardiovascular disease, influenza or asthma.
- ▶ Have likelihood of increased respiratory disease, reduced lung function in children during exercise.
- ▶ Have decreased gas exchange capacity of lungs.
- ▶ Can absorb gaseous pollutants and deliver these directly to the lungs (e.g.  $\text{SO}_2$  condensed on fly ash particles converts to sulfuric acid when inhaled).
- ▶ Fine particles (under 0.2 microns) most dangerous; can contain up to 14 carcinogens.





Haze Particles > 10  $\mu\text{m}$  x 2200



Haze Particles > 1  $\mu\text{m}$  x 15,000

Photomicrograph of haze particles under Scanning Electron Microscopy (SEM).

## Effects on Visibility

Dust soot aerosol  
Suspended Particulate  
matter



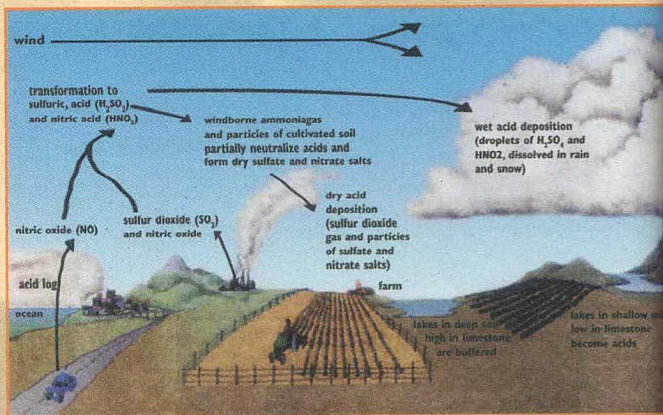
cause light to be  
scattered or absorbed  
thereby reducing  
visibility



- ▶ Atmospheric haze is the condition of decreased visibility caused by the presence of fine suspended particles (0.1 – 1.0  $\mu\text{m}$ ) or  $\text{NO}_2$  in the atmosphere.
- ▶ When haze particles and moisture in the air coagulate, mist and fog are formed which further reduces visibility.

### Haze vs. Smog

- ▶ Smog and haze differ, in terms of intensity and geography. Haze refers to visibility reduction, which is not as intense as that of smog.
- ▶ Smog is often used to describe the marked visibility reduction over cities or large metropolitan areas.
- ▶ On the contrary, haze often refers to the wide-scale low-level pollution-caused visibility reduction.



## Acid Deposition

- ▶ As sulfur dioxide and nitrogen oxides are transported as much as 1,000 kilometers by prevailing winds, they form secondary pollutants such as:
  - Nitric acid vapor
  - Droplets of sulfuric acid
  - Particles of sulfate and nitrate salts.
  
- ▶ These chemicals descend to the earth's surface in :
  - Wet form: acid rain, snow, fog, cloud vapor
  - Dry form: acidic particles
  
- ▶ It damages statues, building, metals and car finishes.
- ▶ It can contaminate fish in some lakes with highly toxic methyl mercury.
- ▶ It can damage foliage and weaken trees, especially shores such as Meranti, Seraya at high elevations.
- ▶ It and other air pollutants can make trees more susceptible to stresses such as cold temperatures, diseases, insects, drought and fungi that thrive under acidic conditions.
- ▶ It contributes to human respiratory diseases such as bronchitis and asthma, which can cause premature death.



This marble monument has been damaged by exposure to acidic air pollutants.

## Damage to Materials

<u>Material</u>	<u>Effects</u>	<u>Principal Air Pollutants</u>
Stone and Concrete	Surface erosion, Discoloration, Soiling.	Sulfur dioxide, sulfur acid, nitric acid, particulate matter
Metals	Corrosion, tarnishing, loss of strength	Sulfur dioxide, sulfuric acid particulate matter, hydrogen sulfide.
Ceramic Glass	Surface erosion	Hydrogen fluoride, particular and matter.
Paints	Surface Erosion, Discoloration	Sulfur dioxide, hydrogen sulfide, ozone, particulate matter.
Paper	Embrittlement, Discoloration	Sulfur dioxide
Rubber	Cracking, loss of strength	Ozone

### Damage to Materials

- ▶ The fallout of soot and grit on building, cars and clothing requires costly cleaning.
- ▶ Air Pollutants break down exterior paint on cars and houses; and deteriorate roofing materials.
- ▶ Irreplaceable marble statues, histories buildings and stained-glass windows throughout the world have been pitted and discolored by air pollutants.

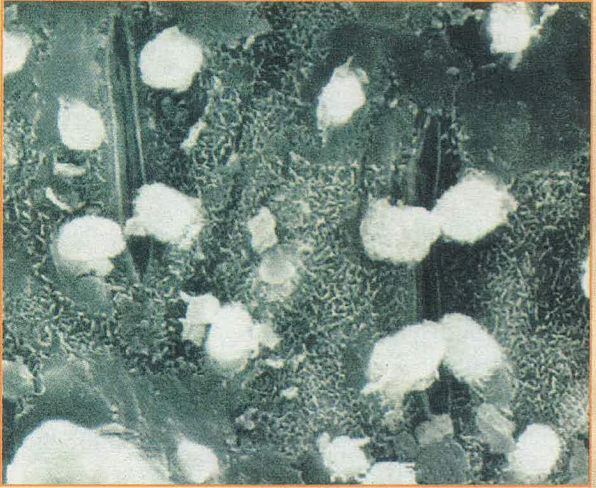
## Ozone Damage to Materials

- ▶ Factors influencing ozone damage include:
  - Nature of the elastomeric compound
  - Degree of stress
  - Ozone concentration
  - Exposure duration
  - Rate of ozone contact with material.
  - Temperature
  - Damage to Elastomers (rubber and rubber-like materials)
    - Cracking will occur in sensitive elastomer
  - Damage to fabric
    - Produce marked fading in most blue dyes; and in some red and yellow dyes.
    - Fading can occur in clothes along folds and edges.

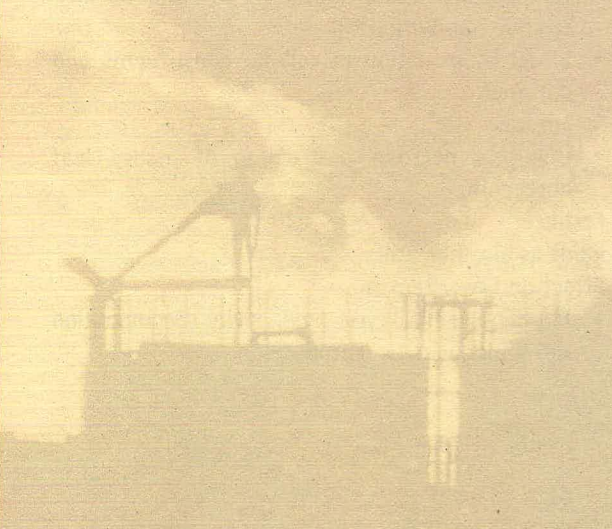
## Effects of Air Pollution on Plants

- ▶ Pollutants :
  - O<sub>3</sub>, SO<sub>2</sub>, Chlorine, Fluorides, PAN, acid from oxides, NO<sub>2</sub>, particulates, unsaturated hydrocarbon, e.g. ethylene
- ▶ Plants:
  - Vegetable, fruits, agricultural crops, grass, shrub, trees, commercial flowers.
- ▶ Susceptibility influenced by:
  - Temperature, wind, light intensity, soil fertility, relative humidity (RH).
  - Effect by oxidation of cellular constituents and enzymes.
- ▶ Symptoms:
  - Chlorosis, necrosis, destruction of tissues, leaf abscission.
- ▶ Fertilizer
- ▶ Plant as bio-indicators
- ▶ Effect on Ecosystem
  - Bio-geo-chemical cycle, productivity, decomposition rates, biodiversity, reproduction.

Stimulated haze particles attach on the leaf of rice.



Stomata of Malaysia cultivar MR211 after exposure to lalang burning (3,500 magnification)



## Definition of Air Pollution Control

- ▶ Public :
  - The limitation or prohibition of pollutant emission by force of the law.
  - One-step, inexpensive solution to "the air pollution problem".
- ▶ Another meaning preventive steps such as environmental education and planning;

## Air Pollution Control Philosophies

- ▶ Emission standard;
- ▶ Air quality standard;
- ▶ Emission taxes;
- ▶ Cost-benefit standard;
- ▶ A perfect air pollution philosophy and its implementing regulations are cost-effective, simple, enforceable, flexible and evolutionary;
  - Cost-effective: gains the maximum possible benefits / reduced damages.
  - Simple : Understandable.
  - Enforceable : clarifies the responsibilities.
  - Flexible : deal with special difficulties
  - Evolutionary : enable to utilize new information.

## Air Pollution Control Program

- ▶ Best Practicable Means (BPM);
- ▶ Air Quality Management System (AQMS); and
- ▶ Standard Air quality criteria and standards.
- ▶ Options;
  - Abandon the business or process
  - Upgrade or modify the process – relocate operation
  - Incorporate appropriate control technology
  - Combination of the above.

## Other Options:

- ▶ Siting and zoning the industries and premises;
- ▶ Specific air pollution control measures in palm oil mills;
- ▶ Installation of packages type and Tee-Pee incinerators in industries; and
- ▶ Installation of incinerator for wood-waste disposal;

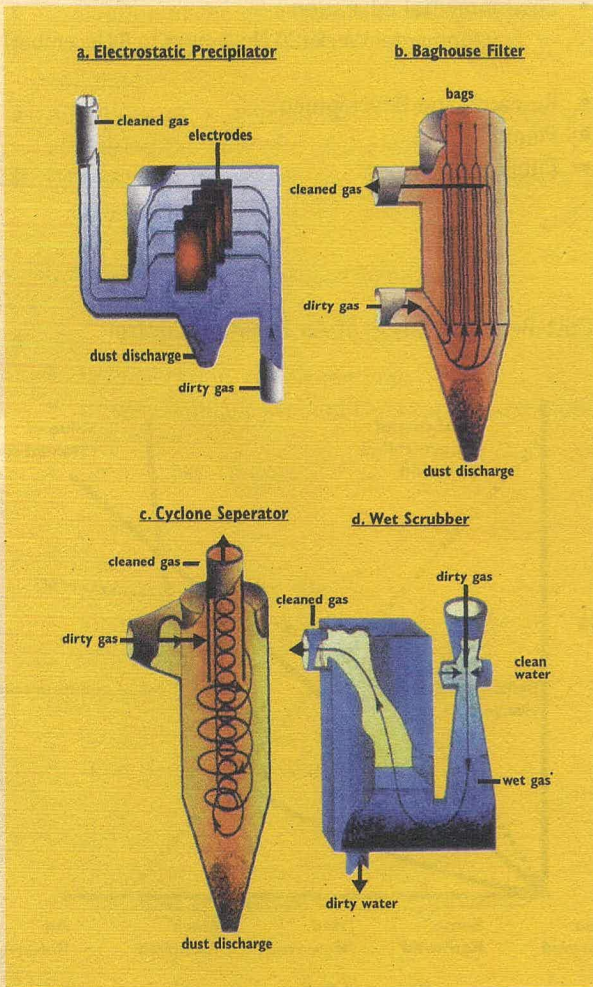
## General Approaches in Air Pollution Control:

- ▶ Proper planning
- ▶ Proactive actions;
- ▶ Stringently applied laws;
- ▶ Use affordable control technologies;
- ▶ Cultivate strong public concern;
- ▶ Provide driver education to the society; and
- ▶ Ensure proper maintenance and operation of diesel and petrol
- ▶ Control the release of marketable permits.

## Control Air Pollution from Industries

- ▶ Settling Chamber: serving as a preliminary screening device:
  - Types of Settling Chambers;
    - Simple settling Chamber
    - Howard Separator
  - Inertial devices;
    - Centrifugal Collectors
    - Reserve-flow cyclone collector
    - Multiple Cyclone
  - Electrostatic Precipitator;
    - One-stage electrostatic precipitator
    - Two-stage electrostatic precipitator
    - Cylindrical two-stage electrostatic precipitator
    - Parallel-plate two-stage electrostatic precipitator
- ▶ Absorbers :
  - Filters ;
    - Soil Purifying (Filtering) System
    - Photo-catalytic Construction Materials and Air-Purifying Sheets
- ▶ Denitrification Equipment;
- ▶ Deodorizing Equipment;
- ▶ Biofiltration of controlling VOCs;

Air Monitoring and Measurement

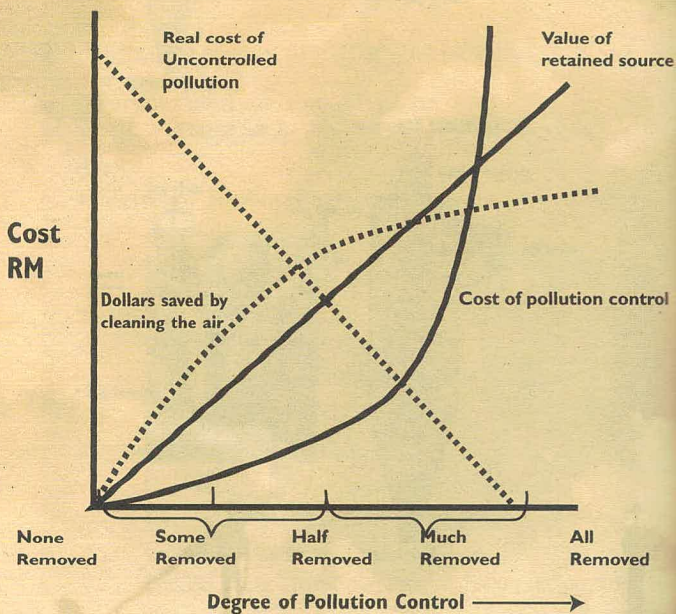


- Cyclone
- Media Filtration
- Particle Scrubbing
- Electrostatic precipitator
- Absorption separator
- Adsorption
- Thermal filtration
- Condensation

## Non-Technology Approaches

- Human's action plays a major role in this approach
- Legislation
- Environmental education :
  - Environmental Week (30 November to 6 December)
- Research and Development
- Planning
- Public involvement

## Cost-Benefit Analysis of Air Pollution Control



## Process of measurement

- ▶ Collection of sample of the air pollutant mixture
- ▶ Treatment of the sample
- ▶ Separation of the pollutant from the air sample
- ▶ Measurement of the desired properties of the pollutants
- ▶ Adoption of a mechanism for controlling and measuring the flow rate of the sample
- ▶ Disposal of the sample gas after measurement is complete.

## Methods of Measuring Gaseous Pollutant

- ▶  $\text{SO}_2$ :
  - Lead-peroxide candle method;
  - British Standard Method (Total acidity method); and
  - West-Gaeke Method
  
- ▶  $\text{NO}_2$ :
  - Saltzman Method; and
  - Chemiluminescence Method
  
- ▶ Hydrocarbons :
  - Gas chromatography; and
  - Total Hydrocarbon Analysis
  
- ▶  $\text{O}_3$  and Oxidants :
  - Potassium iodine method; and
  - Chemiluminescence Method
  
- ▶  $\text{CO}$  :
  - Non-Dispersive Infra-Red Method (NDIR Method);
  - Gas Chromatography; and
  - Detector tube

### Air Quality Criteria

- ▶ Scientifically sound statements about effects that have been observed or inferred to have been produced by various exposures to specific pollutants.
- ▶ Based on analysis and critical review of available information.
- ▶ Describe effects that can be expected to occur whenever the ambient air level of a pollutant reaches or exceeds a specific concentration for a specific time period.

### Use of Air Quality Criteria

- ▶ Dose-response curves
- ▶ Safety factor
- ▶ Reliability of the data
- ▶ Socioeconomic and political consideration.
- ▶ Specific effect against which protection is sought

### Air Quality Standard

- ▶ Prescribe pollutant levels that cannot legally be exceeded during a specific time in a geographical area.
  - Based on Air Quality Criteria.

### Types of data used to develop air quality standard

- ▶ Toxicological Data
- ▶ Epidemiological Data

### Strategies for Controlling Air Pollution

- ▶ Regulation Control (existing laws)
- ▶ Environmental Quality Act 1974
- ▶ Environmental Impact Assessment (EIA)

## ENVIRONMENTAL QUALITY ACT 1974

- ▶ Control of Industry Emissions :
  - Environmental Quality (Clean Air) Regulations, 1978;
    - Various measures to control and abate air pollution.
  - Environmental Quality (Compounding of Offences) Rules, 1978;
- ▶ Control of Motor Vehicle Emission :
  - Environmental Quality (Control of Lead Concentration in Motor Gasoline) Regulations, 1985;
    - Reduction of lead content of petrol.
    - Reduction was gradual, from 0.84 g/l in early 1980s to 0.4 g/l in 1986, to 0.15 g/l in 1990.
  - Environmental Quality (Prohibition on the Use of Chlorofluorocarbons and other gases as Blowing Agents) Order 1993;
  - Environmental Quality (Control of Emission from Diesel Engines) Regulations 1996;
    - Control of black smoke emission from diesel vehicles stipulates a limit of 50 hart ridge smoke units (HSU)
  - Environmental Quality (Control of Emission from Diesel Engines) Regulations 1996;
  - Environmental Quality (Prescribed Activities) (Open Burning) Order 2000.

## ENVIRONMENTAL QUALITY ACT 1974

- ▶ Environment is defined as *the physical factors of the surroundings of the human beings including land, water, atmosphere, climate, sound, odor, taste, the biological factors of animals and plants, and the social; factor of aesthetics.*

### Principles adopted:

- Pollution should be controlled at sources
- Polluters must pay or bear the costs of their waste or wastewater treatment or disposal
- Discharge standards should be uniform for a particular source, type of industry or activity.

## Air Pollution Index (API)

- Based on the sub-index of 5 air quality parameters: PM<sub>10</sub>, CO, SO<sub>2</sub>, NO<sub>2</sub> and O<sub>3</sub>.

**Stage 1** Collect continuous air quality data for the 5 pollutants included in Malaysia API system for a sufficient averaging time periods.

**Stage 2** Carry out the required calibration, validation and quality control for ensuring the reliability of the data.

**Stage 3** Calculate average concentration of the specific air pollutants for the specified averaging time periods.

**Stage 4** Determine specific sub-index value for each of the 5 pollutants based on the average concentrations calculated and with the use of the sub-index functions.

**Stage 5** Report the API at a given time for the preceding averaging period (taking the common end point of 1-hour, 8-hour or 24-hour for all 5 pollutants) in terms of the highest sub-index value obtained; i.e.  $API = \text{Max} \{\text{sub-indices of all 5 air pollutants}\}$ . State the specific air pollutant responsible for the API value as the predominant parameter along with the index;  
State the relevant health effect category of the API reported; report also other sub-indices, if any, which exceed 100 (thereby indicating violation of a Recommended Malaysian Guidelines (RMG)).

## Air Quality and Health Effect Compliance with the API

INDEX VALUE	AIR QUALITY LEVEL	HEALTH EFFECT DESCRIPTION
0	-	-
50	50% of ambient air quality standard	Good
100	Ambient air quality standard	Moderate
200	Alert	Unhealthy
300	Warning	Very unhealthy
400	Emergency	Hazardous
500	Significant harm	Hazardous

### Problems of Air Pollution Control in Malaysia

- ▶ High costs of technology used
- ▶ Lack of real incentives
- ▶ Advantages to pollutant; lack of enforcement
- ▶ Less not sensitive to environmental issues
- ▶ Three Tier System (Federal/State/ Local authorities) of Government; absence of leisure of accountability loopholes in the regulations

".....clean air can not be achieved through study and research. Clean air can only be achieved through an appropriate amount of studies followed by a major commitment to a plan of action."

"...it is not industries or cars that pollute; it is people."

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**Chairman**

Environmental Quality Council, Malaysia



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