Health Effects of Shipping Related Air Pollutants

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Overview

With the South California Coast Air Basin as an example

- Contribution of Marine Vessels to potential health problem
- Lung - the major organ affected
- Health and Environmental Effects of different classes of air pollutants
- Summary and Current Studies

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Marine Vessels are a Major Source of Air Pollution

South Coast Air Quality Management District News 7/8/98

"Ocean going ships, harbor tugs and commercial boats emit TWICE as many smog forming emissions as all of the South coast Air Quality Management District's power plants"

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SCAQMD Estimated Annual Average Emissions 2000 Tons / Day

Source	ROG	CO	NOx	SOx	PM10
Total SC Air Basin	1094	7286	1212	90.3	374.3
Marine: Total	54.3	312.6	54.4	27.2	5.20
" : Commercial	4.29	5.26	43.7	27.1	3.14
" : Recreation	50.0	307.3	10.7	0.17	2.06
% of SC Basin:	Percentages				
Comm. Marine	0.39	0.07	3.61	30.0	0.84
Total Marine	4.96	4.29	4.49	30.2	1.39
Tot. Marine as % Total Mobile	7.96	4.57	5.11	42.2	12.4

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Exposure to Airborne Materials

Average Adult breathes about

11,000 liters / day.

The Respiratory Tract and Lung are
the sites of primary exposure to

air pollutants

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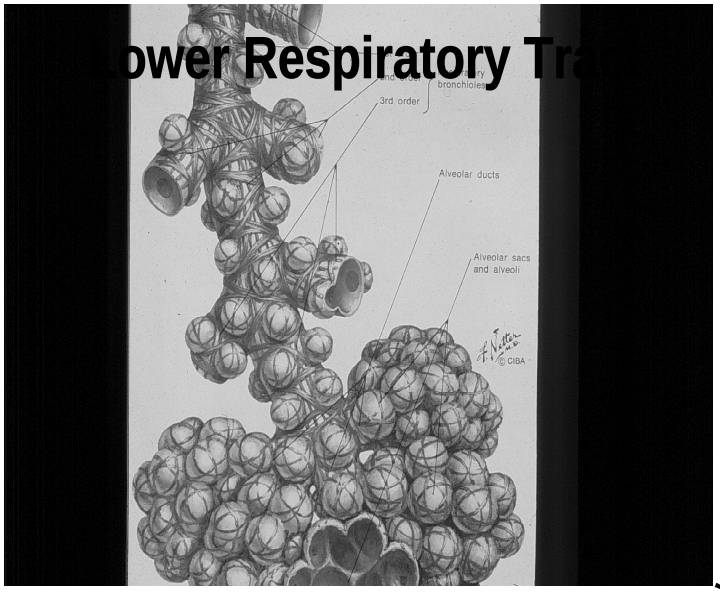
Lower Respiratory Tra



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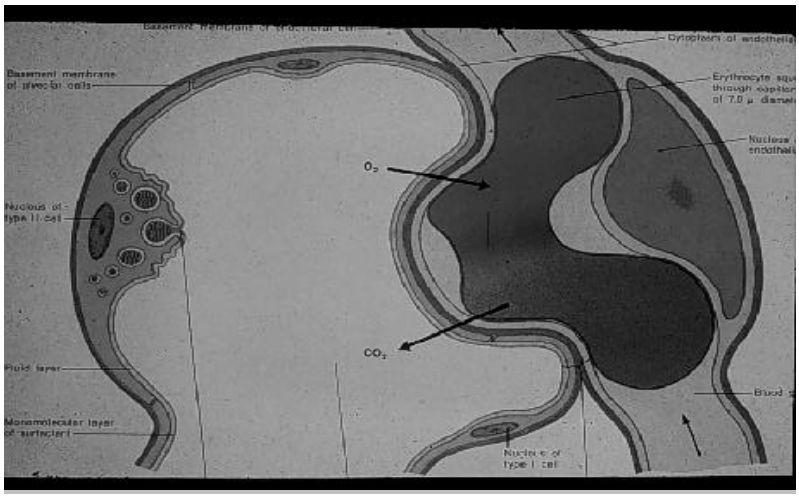
Alveolar / Capillary Interface



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Health Effects of Oxidant Air Pollutants

OXIDANTS **Ozone (O3) and Nitrogen dioxide (NO_2)**

NOx + Reactive Organic Gases (ROG) +

⇩

OZONE

⇩

SMOG

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Health Effects of Oxidants

- Both Ozone and NO2 are strong oxidizing agents and will damage lung tissue, causing inflammation.
- Lung damage, and reduced lung function
- Increased Respiratory Illness
- Aggravates breathing problems, cough, chest pain and Asthma

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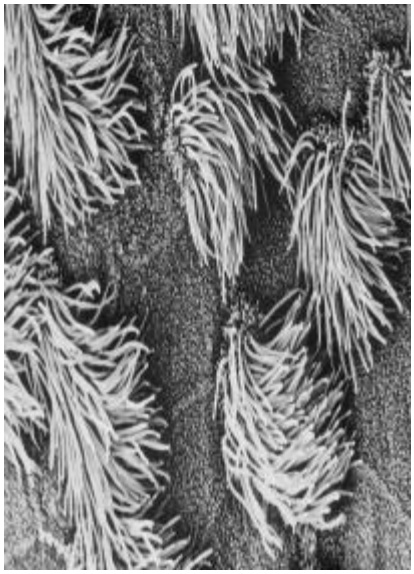

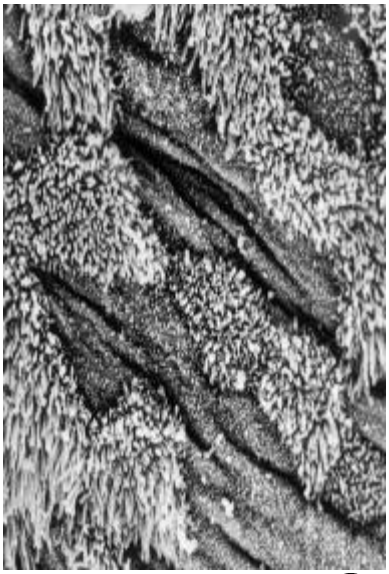

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Environmental Effects of Oxidants NO_2 and O_3

- Oxidant damage to leaves
- Crop loss

  (in CA = $ 300 - 700 million / year)
- Damage to rubber and plastics
- Damage to Ecosystems

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Sulfur Dioxide Health Effects

Short Term Exposure :

- Irritates and Restricts Airways
- Chest Tightness
- Reduces Mucus Clearance

Long Term Exposure, few studies, but suggest :

- Bronchitis
- Suppresses Immune System

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Sulfur Dioxide in the Environment

- **Effective restrictions on sulfur content of fuels -**
- **Ambient SO_2 in CA** ⇩ **by > 60% over 20 years**
- **Shipping** produces considerable percent of total SO_2 in **CA**.
- **SO_2 Remains problem in Eastern USA**

  Acid Rain, deposition ⟶ degradation of crops, water, environment

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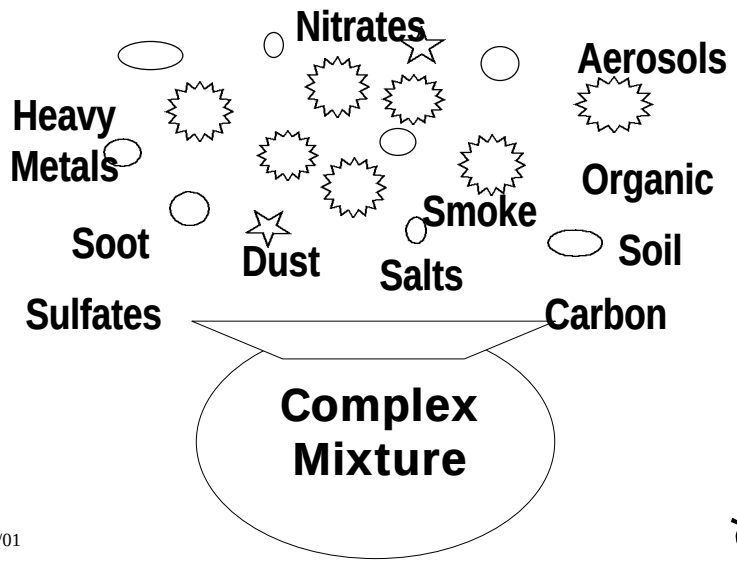
Particulate Matter (PM)



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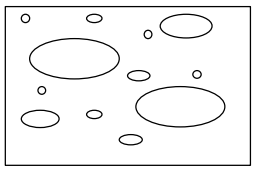
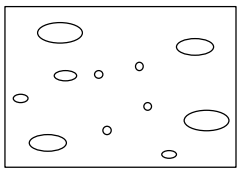
What are PM10 and PM2.5?





PM 10: Particulate material with a diameter of 10 microns or less

PM 2.5: Particulate material with a diameter of 2.5 microns or less

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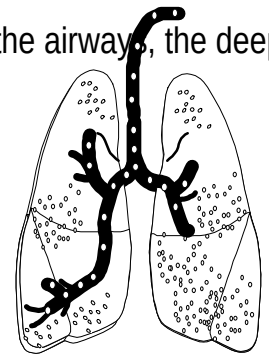
What particles are of concern?

- Particles 10 microns or less (PM10) bypass body's defenses and enter lung
- Coarse fraction (>2.5-10 μm) deposits in the airways, the deep lung
- Fine fraction (<2.5 μ m) easily penetrates to deep lung
- Ultrafine fraction (<0.1 μ m) like gases--spread throughout lung



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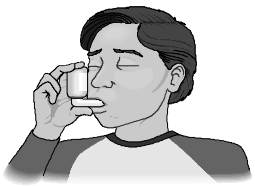
What are the health effects of particles?

Studies show particles damage lungs:

- Increase asthma attacks
- Aggravate bronchitis
- Reduce lung function growth in children
- Contribute to premature death and hospital visits of people with respiratory and cardiac problems



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Health Effects of Diesel and Heavy Fuel Oils

- **Ultrafine PM** (< 0.1μm) associated with:
  - Respiratory Illness, Cancer,
    Asthma (bound allergens)
    Cardiovascular Disease
    Decreased lung function
- **Toxic Air Contaminants** - Lung and Bladder cancer
- **Pollutant gases** - Respiratory , Cardiopulmonary and ecological effects

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Diesel PM's Contribution to Potential Cancer Risk from Ambient Air in California

Component	Cancer Risk * Excess Cancers / million people	Contribution to total Risk
Total Cancer Risk	758	
Diesel Exhaust PM	540	71.2%
1,3 Butadiene	74	9.8%
Benzene	57	7.5%
Other VOCs **	78	10.4%

Based on the 2000 Emission Inventory, assuming exposed for 70 years, inhalation route only.
**** Carbon tetrachloride, polycyclic aromatic hydrocarbons, e.t.c.**

ARB October 2000

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Health Effects - Summary

Urban Ambient Air Quality is still not acceptable

- Oxidant levels (smog)
- PM
- Toxic Air Contaminants (TACs)

Marine Vessels contribute to Air Pollution on land

- major problems NOx and ROG (form Ozone)
- PM (Ultrafines from Diesel) and TACs
- SOx

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What we still need to know: Current Studies (ARB)

Long term Effects of Air Pollution

Children's Health Study (USC)

Fresno Asthmatic Children's Environment Study (UCB)

Mechanism of Effect of PM especially Ultrafines

Ambient Aerosol Concentrator / Toxicology (UCLA / USC)

Investigation of Complex Mixes

Ozone, NO_2 and CO / Controlled Exposures (UCSF)

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