

A. Air Pollutants

1. Criteria Air Pollutants.

In the US, the ambient air concentrations are measured and regulated for the 6 criteria air pollutants, CO, SO₂, O₃, NO₂, particles, and lead as promulgated by the US Congress (in the late 1960's before EPA was formed). *Note that CO₂ is not a criteria air pollutant.*

a. Gases

CO	carbon monoxide
SO ₂	sulfur dioxide
O ₃	ozone
NO ₂	nitrogen dioxide

b. Particles

PM10	particles of aerodynamic diameter less than 10 microns (or micrometers)
PM2.5	particles of aerodynamic diameter less than 2.5 microns
Lead	lead is a toxic metal, causes brain damage in children

aerodynamic diameter is the diameter of a spherical particle of unit density (density = 1 gram/cubic centimeter) which has a gravity settling velocity equal to the gravity settling velocity of the actual particle in atmospheric air

2. Hazardous Air Pollutants

In the US, the ambient air concentrations are *not* measured and regulated for hazardous air pollutants (Ambient criteria air pollutants are measured and have air quality Standards). The Clean Air Act amendments passed by the US Congress in 1977 told the EPA to identify those air pollutants which were hazardous to human health and to establish air quality standards for these air pollutants. By 1990 only 7 standards had been identified by EPA for hazardous air pollutants including asbestos, beryllium, mercury, vinyl chloride, benzene, radio nuclides, and arsenic. Some of these hazardous air pollutants were identified as the result of US Federal Court cases in which law suits were filed using human health illness and death (mortality) data and the US Federal Court directed the EPA to identify the air pollutant as hazardous. In 1990 the US Congress with leadership from Senator George Mitchell (State of Maine) and in cooperation with President Bush identified 189 hazardous air pollutants and mandated that the best available emission control technology be used to control the emissions of these air pollutants from new facilities. Page 554 of Wark, Warner, and Davis presents a list of these 189 "HAPs" or hazardous air pollutants.

3. Diesel engine formed particles.

The particulate emissions from diesel engines have long been known to be toxic and carcinogenic but the trucking, government (cities use diesel buses), and industrial lobbies were able to prevent the diesel engine particles from being officially classified as a hazardous air pollutant. In the past 10 years, it has been shown that about 70% of the air pollutant caused cancer risk is *entirely* due to diesel engine air pollutant emissions (primarily the particles) so finally there are US Federal emission regulations on diesel engines (2005 diesel engines on cars and trucks will still probably have no tailpipe controls whereas gasoline engines on autos have had catalytic converters since about 1975) which will require catalytic converters and filters on diesel engines for autos and trucks starting in about 2007. Some school buses and city metro buses presently have catalytic converters and some also have particle filters. The use of special fuels (biodiesel) does reduce diesel engine emissions some, but this is primarily a program to subsidize farm products. Diesel engines emit a great deal of nitrogen oxides (NO_x). 2009 diesel motor vehicles sold in the US must meet NO_x emission standards (some diesel vehicles will use liquid urea solution in their NO_x emission control system).

Respiratory health of children measured to be related to diesel air pollution concentration

Particulate matter and NO₂ appear to be the most strongly associated with the development of chronic lower respiratory symptoms in asthmatic children. Initial results indicate that exposure to air pollutants retards the growth of lung function in children. NO₂ (perhaps as an indicator of exposure to traffic exhaust) appears to be highly associated with this effect in young children.

Human Health Risk

For a site to be classified as an US Superfund Site, there needs to be sufficient pollution in the soil or ground water to have the human health risk be greater than one cancer death in one million people risk of cancer death over a 70 year lifetime exposure. But the air we breathe in this classroom (More 221) has a human health risk of the range of one in 10,000 to one in 100,000 so if the US Government used the same human health risk criteria for air as for soil and groundwater, *all* urban areas in the US would be "air superfund sites". Which groups lobby the US Federal Government against identifying urban area as "air superfund sites"?

Note that there are no standards for indoor air in buildings such as More Hall or other University of Washington buildings. There are US Occupational Safety & Health Administration (OSHA) and Washington State Department of Labor and Industries (WISHA) air standards for indoor air in the industrial workplace. Permissible exposure limit = PEL.

OSHA has 500 PELs <http://www.osha.gov/SLTC/pel/>

OSHA PELs are based on an 8-hour time weighted average (TWA) exposure to an air pollutant.

Time weighted average (TWA) is the employee's average airborne exposure to any 8-hour work shift of a 40-hour work week which shall not be exceeded.

Short term exposure limit (STEL) is the employee's 15-minute time weighted average exposure which shall not be exceeded at any time during a work day unless another time limit is specified in a parenthetical notation below the limit. If another time period is specified, the time weighted average exposure over that time period shall not be exceeded at any time during the working day.

B. Effects of Air Pollution

1. Human health effects

a. asthma

asthma is aggravated by air pollutants

admissions to hospitals and clinics related to air pollutants

2. damage to plants

3. visibility reduction

a. a dust storm Sat 9/25/99 in Eastern Oregon caused 7 deaths in an accident where large trucks slowed down and stopped and cars collided with the stopped trucks.

b. US National Park Service is concerned with the loss of views in US National Parks and have requested (required ?) action be taken to improve visibility at the Grand Canyon and other National Parks.

c. What is the cause of the visibility reduction in Seattle today?

fog (fog droplet diameter about 4-8 microns)

small air pollutant particles emitted from motor vehicles (primarily diesel engines and old vehicles not having catalytic converters)

wood smoke

4. acid rain

a. the pH of rain has been measured to be acidic in many US locations, primarily in the Eastern US. Acid rain kills fish, trees, and plants.

b. To reduce the acidity of rain in the US, coal-fired power plants are supposed to reduce their SO₂ emissions. The Centralia Coal-Fired power plant removes about 95% of the SO₂ in the stack gases using limestone slurry wet scrubbers

5. **water pollution**

- a. about 85% of the PCB's entering the Great Lakes comes from air pollution.
- b. airborne NO & NO₂ contribute significant nitrate pollution to Chesapeake Bay

6. **radioactive pollutants**

radioactive pollutant emissions from bomb testing, nuclear industry, and nuclear reactors are transported all over the world via the atmospheric air. The increase in leukemia over the past 60 years (since about 1944) is thought to be related to radioactive exposure.

C. Air Pollutant Emission Sources

1. **SO₂ Sulfur Dioxide**

Combustion of fuels containing sulfur is a major source of sulfur oxides SO_x air pollutant emissions. US gasoline and diesel have had the highest sulfur content of any fuels in the world (the result of a strong oil and coal lobby in the US). The US has very large coal deposits and States such as Illinois, Ohio, Kentucky, West Virginia, and Tennessee promote coal combustion and are very strong lobbies which have influenced the US Congress to not pass legislation to reduce sulfur oxide emissions.

Also SO₂ is emitted from smelters of copper ore and lead ore but many of the US smelters have shut down. The ASARCO copper smelter near Tacoma Washington shut down in the 1980s. With a rated capacity of 4.5 million pounds of copper per month, by 1920 the Clarkdale Arizona smelter was one of the largest in the world. Many of the farms and fruit orchards were bought up by the smelter owner in order to avoid conflicts over the harsh effects of the sulfur smoke on the vegetation; so there were few trees or living plants in town when the smelter was operating. The Town of Clarkdale is situated in the Verde Valley, located in the North Central part of Arizona.

2. **NO_x Nitrogen Oxides**

Fuel combustion in motor vehicles. Fuel combustion in power plants. NO_x formation related to high temperature and high pressure such as exists in combustion processes.

3. **CO Carbon Monoxide**

Incomplete combustion. Motor vehicles are the major source of carbon monoxide. Fairly easy to control by having the internal combustion engines burn cleanly and having catalytic converters (which gasoline engine autos have had since about 1975). Poorly maintained motor vehicles are the major source of CO. Governments so far have avoided regulations on older motor vehicles (ie would be very cost effective to ban high polluting motor vehicles from streets and highways but so far this has not been done in the US - probably because old polluting autos are owned by poor people and most city governments such as Seattle heavily subsidize folks "of low economic status" with low-income housing, not requiring drivers to have the required auto insurance or driver's license, etc.).

4. **Particles**

Fine particles emitted by diesel engines and gasoline engines.

Fine particles also formed in atmosphere by chemical reactions (photochemical smog, and SO₂ reacting to form sulfates such as ammonium sulfate or (NH₄)₂SO₄

Industrial plants, Wood combustion in home stoves and fireplaces

5. **Lead**

Lead smelters (ASARCO lead smelter in Montana, lead battery recycling plants)

paint flaking from old buildings

lead phased out from use in gasoline many years ago.

D. What are the air pollutant emission sources near More 221 (on or near UW Campus) which pollute the air we breathe in this room?