

## **Air pollutants Explained**

The following pollutants are described below in more detail

Carbon monoxide (CO)  
Nitrogen Dioxide (NO<sub>2</sub>)  
Ozone (O<sub>3</sub>)  
Particles (PM<sub>10</sub>)  
Sulphur dioxide (SO<sub>2</sub>)  
Lead

### **Carbon monoxide (CO)**

#### **Sources**

Carbon monoxide is an odourless colourless gas that is a product of the incomplete combustion of fuel containing carbon. Road vehicles account for 90% of CO emissions. The emission rate for individual vehicles depends critically on vehicle speed, being higher at very low speeds. Concentrations are highest at the kerbside, and decrease rapidly with increasing distance from the roadway. There are a small number of industrial processes that can make significant contributions to ground level concentrations of CO. The Air Quality Objective for CO is 10 parts per million (ppm) as a running 8-hour mean to be achieved by December 2005. The objective applies to locations where persons may be exposed over an 8-hour period.

#### **The health effects of Carbon Monoxide**

The main threats to human health from exposure to carbon monoxide are the formation of carboxyhaemoglobin, which substantially reduces the capacity of the blood to carry oxygen and deliver it to the tissues, and blockage of important biochemical reactions in cells. People who have an existing disease that affects the delivery of oxygen to the heart or brain are likely to be at particular risk if these delivery systems are further impaired by carbon monoxide.

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

#### **Sources**

Nitrogen oxides are formed during high temperature combustion processes from the oxidation of nitrogen in the air or fuel. The principal source of nitrogen oxides - nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>), collectively known as NO<sub>x</sub> - is road traffic, which is responsible for approximately half the emissions in Europe. NO and NO<sub>2</sub> concentrations are therefore greatest in urban areas where traffic is heaviest. Other important sources are power stations, heating plants and industrial processes. Nitrogen oxides are released into the atmosphere mainly in the form of NO, which is then readily oxidised to NO<sub>2</sub> by reaction with ozone. Elevated levels of NO<sub>x</sub> occur in urban environments under stable meteorological conditions, when the air mass is unable to disperse.

## **Health and environmental effects**

Nitrogen dioxide has a variety of environmental and health impacts. It is a respiratory irritant, may exacerbate asthma and possibly increase susceptibility to infections. In the presence of sunlight, it reacts with hydrocarbons to produce photochemical pollutants such as ozone (see below). In addition, nitrogen oxides have a lifetime of approximately 1 day with respect to conversion to nitric acid. This nitric acid is in turn removed from the atmosphere by direct deposition to the ground, or transfer to aqueous droplets (e.g. cloud or rainwater), thereby contributing to acid deposition.

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

### **Sources**

Unlike other primary pollutants, ozone (O<sub>3</sub>), is not emitted directly into the atmosphere, but is a secondary pollutant produced by reaction between nitrogen dioxide (NO<sub>2</sub>), hydrocarbons and sunlight. Whereas nitrogen dioxide (NO<sub>2</sub>) participates in the formation of ozone, nitrogen oxide (NO) destroys ozone to form oxygen (O<sub>2</sub>) and nitrogen dioxide (NO<sub>2</sub>). For this reason, ozone levels are not as high in urban areas (where high levels of NO are emitted from vehicles) as in rural areas. As the nitrogen oxides and hydrocarbons are transported out of urban areas, the ozone-destroying NO is oxidized to NO<sub>2</sub>, which participates in ozone formation. Sunlight provides the energy to initiate ozone formation; near-ultra-violet radiation dissociates stable molecules to form reactive species known as free radicals. In the presence of nitrogen oxides these free radicals catalyse the oxidation of hydrocarbons to carbon dioxide and water vapour. Partially oxidised organic species such as aldehydes, ketones and carbon monoxide are intermediate products, with ozone being generated as a by-product. Since ozone itself is photo-dissociated (split up by sunlight) to form free radicals, it promotes the oxidation chemistry, and so catalyses its own formation (ie it is an autocatalyst). Consequently, high levels of ozone are generally observed during hot, still sunny, summertime weather in locations where the air mass has previously collected emissions of hydrocarbons and nitrogen oxides (e.g. urban areas with traffic). Because of the time required for chemical processing, ozone formation tends to be downwind of pollution centres. The resulting ozone pollution or "summertime smog" may persist for several days and be transported over long distances.

## **Health and environmental effects**

Ozone can irritate the eyes and air passages causing breathing difficulties and may increase susceptibility to infection. It is a highly reactive chemical, capable of attacking surfaces, fabrics and rubber materials. Ozone is also toxic to some crops, vegetation and trees.

## **Particles (PM<sub>10</sub>)**

### **Sources**

Airborne particulate matter varies widely in its physical and chemical composition, source and particle size.

A major source of fine primary particles are combustion processes, in particular diesel combustion, where transport of hot exhaust vapour into a cooler tailpipe or stack can lead to spontaneous

formation of "carbon" particles before emission. Secondary particles are typically formed when low volatility products are generated in the atmosphere, for example the oxidation of sulphur dioxide to sulphuric acid. The atmospheric lifetime of particulate matter is strongly related to particle size, but may be as long as 10 days for particles of about 1mm in diameter.

The principal source of airborne PM10 matter in European cities is road traffic emissions, particularly from diesel vehicles. As well as creating dirt, odour and visibility problems, PM10 particles are associated with health effects including increased risk of heart and lung disease. In addition, they may carry surface-absorbed carcinogenic compounds into the lungs.

## **Health Effects**

PM10 particles (the fraction of particulates in air of very small size (<10 µm)) are of major current concern, as they are small enough to penetrate deep into the lungs and so potentially pose significant health risks. Larger particles meanwhile, are not readily inhaled, and are removed relatively efficiently from the air by sedimentation. Particles are often classed as either primary (those emitted directly into the atmosphere) or secondary (those formed or modified in the atmosphere from condensation and growth).

Concern about the potential health impacts of PM10 has increased very rapidly over recent years. Increasingly, attention has been turning towards monitoring of the smaller particle fraction PM2.5 capable of penetrating deepest into the lungs, or to even smaller size fractions or total particle numbers.

## **Sulphur dioxide (SO<sub>2</sub>)**

### **Sources**

The principal source of this gas is power stations burning fossil fuels that contain sulphur. Major SO<sub>2</sub> problems now only tend to occur in cities in which coal is still widely used for domestic heating, in industry and in power stations. As some power stations are now located away from urban areas, SO<sub>2</sub> emissions may affect air quality in both rural and urban areas. Since the decline in domestic coal burning in cities, and in power stations overall, SO<sub>2</sub> emissions have diminished steadily and, in most European countries, they are no longer considered to pose a significant threat to health.

Of particular concern in the past was the combination of SO<sub>2</sub> and black smoke and particulate matter; current EC Directive Limit Values for SO<sub>2</sub> are defined in terms of accompanying black smoke levels, although these are likely to change.

### **Health Effects**

Sulphur dioxide is a corrosive acid gas that combines with water vapour in the atmosphere to produce acid rain. Both wet, and dry deposition is implicated in the damage and destruction of vegetation and in the degradation of soils, building materials and watercourses. SO<sub>2</sub> in ambient air is also associated with asthma and chronic bronchitis.

## **Lead**

Particulate metals in air are the results of activities such as fossil fuel combustion (including vehicles), metal processing industries and waste incineration. There are currently no EC standards for metals other than lead, although several are under development. Lead is a cumulative poison to the central nervous system, particularly detrimental to the mental development of children.

Lead is the most widely used non-ferrous metal and has a large number of industrial applications. Its single largest industrial use worldwide is in the manufacture of batteries (60-70% of total consumption of some 4 million tonnes) and it is also used in paints, glazes, alloys, radiation shielding, tank lining and piping.

As tetraethyl lead, it has been used for many years as an additive in petrol; most airborne emissions of lead in Europe therefore originate from petrol-engined motor vehicles. With the increasing use of unleaded petrol, and the introduction of lead replacement petrol (LRP) for vehicles which cannot run on unleaded petrol, emissions and concentrations in air have declined rapidly in recent years.