Air Emissions in My Community web tool

Substance information

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Contents

Abbreviations

Air Toxics NEPM	National Environment Protection (Air Toxics) Measure
Ambient Air Quality NEPM	National Environment Protection (Ambient Air Quality) Measure
GMR	Greater Metropolitan Region NSW
IARC	International Agency for Research on Cancer
NO_x	Oxides of nitrogen
PM	particulate matter (TSP, $PM_{2.5}$, PM_{10})
ppb	parts per billion
ppm	parts per million
TSP	Total suspended particles
TEF	toxic equivalence factor
TEQ	toxic equivalence quotient
VOC	volatile organic compounds
USEPA	United States Environmental Protection Agency

Information on the substances included in the Air Emissions in My Community web tool is provided below, grouped into criteria substances, organic compounds and other substances. Click on the hyperlinks below while pressing the Ctrl key to jump to the information on each substance.

1. Criteria substances

Criteria substances are commonly found in ambient air and regulated under the National Environment Protection (Ambient Air Quality) Measure (Ambient Air Quality NEPM; NEPC 2011).

The Ambient Air Quality NEPM substances are:

- carbon monoxide (CO)
- lead and compounds (Pb)
- nitrogen dioxide (NO_2), which is one component of oxides of nitrogen (NO_x). NO_x includes both NO_2 and nitric oxide (NO)
- ozone (O_3), which is an indicator of photochemical smog. Ozone is a secondary pollutant rather than a direct emission and is formed through atmospheric reactions between volatile organic compounds (VOC) and NO_x in the presence of sunlight. Ozone is not included in the Air Emissions in My Community web tool.
- particulate matter with an aerodynamic equivalent diameter less than 10 micrometres (PM_{10})
- particulate matter with an aerodynamic equivalent diameter less than 2.5 micrometres ($PM_{2.5}$)
- sulfur dioxide (SO_2).

The Ambient Air Quality NEPM requires jurisdictions to monitor and report on ambient air quality and actions taken to achieve the ambient air quality standards.

You can either view updated hourly ambient concentrations or search and download historical air quality data where you live or download the Ambient Air Quality NEPM annual report (NEPC 2011) for more information about ambient air quality.

2. Organic compounds

Organic compounds are built on a carbon chain or ring and also include hydrogen atoms, with some also including oxygen and other atoms. Common organic compounds include the large mix of hydrocarbons in petrol and diesel fuel, and oxygenated hydrocarbons such as ethanol. Many individual organic compounds are toxic and are also precursors to the formation of photochemical smog and secondary particles.

Some organic compounds are commonly found in ambient air and regulated under the National Environment Protection (Air Toxics) Measure (Air Toxics NEPM; NEPC 2004).

The Air Toxics NEPM substances are:

- benzene
- benzo(a)pyrene as a marker for polycyclic aromatic hydrocarbons (PAH)
- formaldehyde
- toluene
- xylenes (as total of ortho, meta and para isomers).

The Air Toxics NEPM requires jurisdictions to monitor and report on levels of air toxics in ambient air.

You can download the NSW EPA Air Toxics Study reports (EPA 2002, 2012; OEH 2013) or the Air Toxics NEPM annual report (NEPC 2010) for more information about air toxics in ambient air.

The other organic compounds included in the Air Emissions in My Community web tool are:

- total volatile organic compounds
- 1,3-butadiene
- acetaldehyde
- polychlorinated dioxins and furans (PCDD and PCDF).

3. Other substances

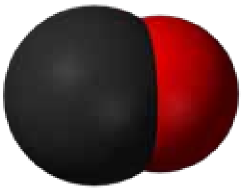
Substances that are not either criteria substances or organic compounds are:

- ammonia (NH_3), which is a precursor to the formation of secondary particles.

Carbon monoxide

Characteristics

Carbon monoxide (CO) is a colourless, odourless gas and is the most common pollutant by mass in the atmosphere. Its chemical formula is CO and its molecular structure is shown below.



$:C\equiv O:$

Sources

CO is a product of the incomplete combustion of fuels. The main sources of CO in the NSW Greater Metropolitan Region (GMR) are EPA-licensed industry and road transport, while the largest source in Sydney is road transport.

Health

CO can have harmful effects on human health. These effects (which depend on exposure time and concentration in ambient air) are related to the formation of carboxyhaemoglobin in the blood, which reduces the capacity of the blood to carry oxygen. People suffering from heart disease are most at risk. They may experience chest pain if they are exposed to carbon monoxide, particularly while exercising.

Standards and measured levels

The Ambient Air Quality NEPM prescribes an ambient air standard for CO of 9 ppm as an 8-hour average.

Elevated concentrations of CO in ambient air mainly occur in areas with high traffic density and poor dispersion.

Current air quality in NSW (DECCW 2010) shows that ambient CO levels in NSW have steadily declined, with no exceedance of the Ambient Air Quality NEPM standard for more than 10 years. Measured maximum 8-hour concentrations of CO in ambient air are around 2 ppm.

Lead and compounds

Characteristics

Lead is a soft heavy metal that is found in ambient air as minute particles and forms a component of particulate matter (TSP, PM_{10} and $PM_{2.5}$). Its elemental symbol is Pb.

Sources

Lead is emitted into ambient air from both mobile and stationary sources. The largest source of lead emissions in the GMR is from wheel generated dust caused by haulage trucks used at coal mines, whereas the largest source in Sydney is road, brake and tyre wear from road transport.

Health

Lead is a highly toxic metal that is poisonous in all forms. It is absorbed into the human body through both ingestion and inhalation and accumulates in the body. The main concern about lead in ambient air is its potential to impair intellectual development in children. At high concentrations in ambient air, lead can also have a wide range of other health effects, particularly on the blood, central nervous system and gastrointestinal system.

Standards and measured levels

The Ambient Air Quality NEPM prescribes an ambient air standard for lead of 0.5 micrograms per cubic metre ($\mu g/m^3$) as an annual average.

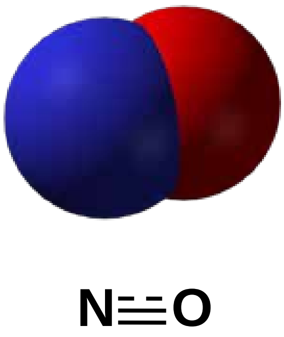
Lead concentrations in ambient air may be elevated near EPA-licensed industry and commercial business premises that manufacture metals or use coal as a fuel source.

Although lead in ambient air has not been routinely monitored in NSW since 2005, Current air quality in NSW (DECCW 2010) shows that ambient lead levels in NSW have dropped to less than 10 per cent of the Ambient Air Quality NEPM standard.

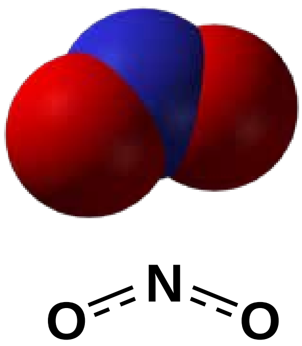
Oxides of nitrogen

Characteristics

Oxides of nitrogen (NO_x) mainly consist of nitric oxide (NO) and nitrogen dioxide (NO_2), which are collectively referred to as NO_x. NO is a colourless gas with a sweet odour, while NO_2 is a reddish brown gas with a biting acrid odour. Their chemical formulae are NO and NO_2 and their molecular structures are shown below.



Nitric oxide



Nitrogen dioxide

Sources

NO_x is formed through the combustion of fuels, by lightning strikes and microbial activity in soil. Nitric oxide is the most abundant form of NO_x. Combustion sources emit about 90–95 per cent as NO and 5–10 per cent as NO_2. Additional NO_2 is produced in ambient air when NO oxidises through atmospheric photochemical reactions. EPA-licensed industry, in particular coal-fired electricity generation, is the largest source of NO_x emissions in the GMR, whereas the largest source in Sydney is road transport.

Health

The reactive nature of NO_2 makes it a particular concern for human health. It can cause inflammation of the respiratory system and increase susceptibility to respiratory infection. Exposure to elevated concentrations of NO_2 has also been associated with increased mortality, particularly related to respiratory disease, and increased hospital admissions for asthma and heart disease patients.

In addition to its direct adverse health effects, NO_2 plays a key role in atmospheric photochemical reactions that form both ground-level ozone and secondary particles.

Standards and measured levels

The [Ambient Air Quality NEPM] prescribes ambient air standards for NO_2 of 0.12 ppm as a 1-hour average and 0.03 ppm as an annual average.

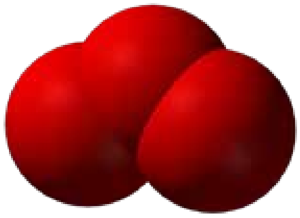
In urban areas, elevated concentrations of NO_2 in ambient air mainly occur in the cooler months, when lower temperatures and less sunlight mean that the NO_2 does not readily react in atmospheric photochemistry. Elevated concentrations of NO_2 in ambient air mainly occur in areas with high traffic density and poor dispersion.

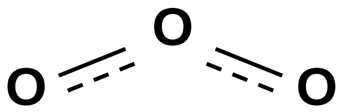
Current air quality in NSW (DECCW 2010) shows that ambient NO_2 levels in NSW have slowly declined, with no exceedances of the Ambient Air Quality NEPM standards for more than 10 years. For NO_2 in ambient air, measured maximum 1-hour concentrations are around 0.04 ppm while annual average concentrations are around 0.01 ppm.

Ozone

Characteristics

Ozone is a colourless and highly reactive gas with a distinct sharp odour reminiscent of chlorine, which is detectable above approximately 10 ppb. Ozone's chemical formula is O_3 and its molecular structure is shown below.





Sources

Ozone occurs in both the upper atmosphere (the ozone layer) and at ground level. The ozone layer in the upper atmosphere is beneficial to life by shielding the Earth from harmful ultraviolet radiation from the sun.

At ground level, ozone is a secondary pollutant that is not directly emitted, but rather is formed in the atmosphere by chemical reactions of precursor pollutants including VOC and NO_x. These reactions are driven by strong sunlight and are termed photochemical reactions. Ozone is more readily formed during the summer months and reaches its highest concentrations in the afternoon or early evening.

While other compounds are formed in these photochemical reactions, ozone is commonly monitored in ambient air because it is a key component and measure of photochemical smog. Ozone is not included in the Air Emissions in My Community web tool.

Health

Ozone is a strong oxidant and causes damage and irritation to the mucus membranes and respiratory tract. Ozone can trigger a variety of health problems including chest pain, coughing, throat irritation, and congestion. It can worsen bronchitis, emphysema and asthma. Ground level ozone can also reduce lung function and inflame the linings of the lungs. People with lung disease, children, older adults, and people who are active outdoors may be particularly sensitive to ozone.

Standards and measured levels

The Ambient Air Quality NEPM prescribes ambient air standards for ozone of 0.1 ppm as a 1-hour average and 0.08 ppm as an 8-hour average. Elevated levels generally occur on hot summer days in cities where sufficient levels of VOC and NO_x precursors are present.

Ozone levels are currently monitored at 12 sites across Sydney, three each in the lower Hunter and Illawarra, and one at the Central Coast. Current air quality in NSW

(DECCW 2010) shows that ambient ozone concentrations in the Sydney region have exceeded either or both of the Ambient Air Quality NEPM standards every year since 1994. The number of days when the 1-hour standard was exceeded in Sydney ranged from none in 1995 to 19 in 2001. Concentrations can be as much as double the Ambient Air Quality NEPM standards.

Ozone exceedences are less frequent in the Illawarra, occurring on up to 7 days a year. The lower Hunter region has recorded only two exceedences of the 1-hour standard since 1999.

Both ozone standards are exceeded throughout the warmer months, from October to April, and peak between December and January. No significant trends are apparent in the number of exceedence days per year for either standard. The 1-hour standard is rarely exceeded without a corresponding exceedence of the 4-hour standard.

Particulate matter

Characteristics

Particulate matter refers to matter suspended in ambient air, including solid particles, liquid droplets and aggregates of particles and liquids. The particles are made up of a number of components, including soot, nitrates and sulfates, organic chemicals, metals and soil or dust particles. While most particles are emitted directly, secondary particles can also be formed by the chemical reaction of gaseous pollutants. Typical primary and secondary particles are shown below.

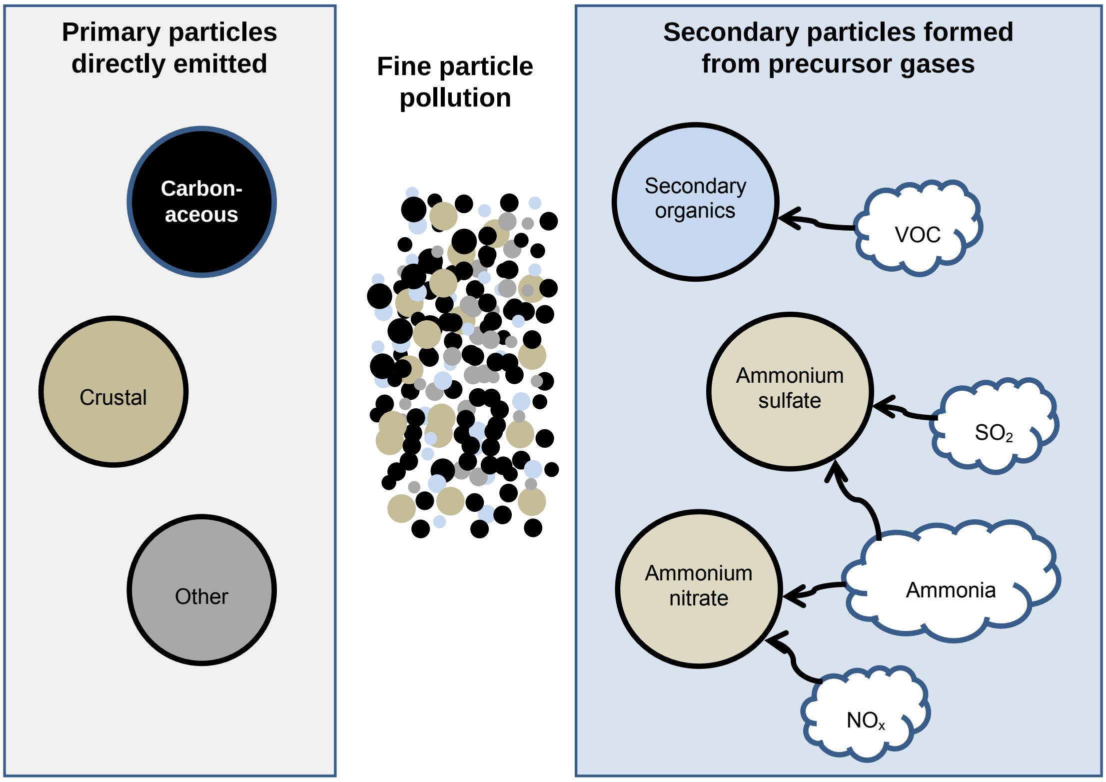


Figure 1 Typical primary and secondary particles in particulate matter

Particles in ambient air range in diameter from 0.01 micrometres (µm) to about 50 µm. Typically, larger particles are deposited within minutes to hours, while smaller particles can stay suspended in ambient air for days or weeks. Rainfall is an important mechanism for removing particles from ambient air.

PM is classified by size as total suspended particles (TSP), PM_{10} and $PM_{2.5}$. Particles occur in a wide range of shapes and are rarely spherical. The size is classified in terms of how they behave in air relative to spherical particles and this is termed the aerodynamic diameter. Different particle sizes are compared with human hair and beach sand below.

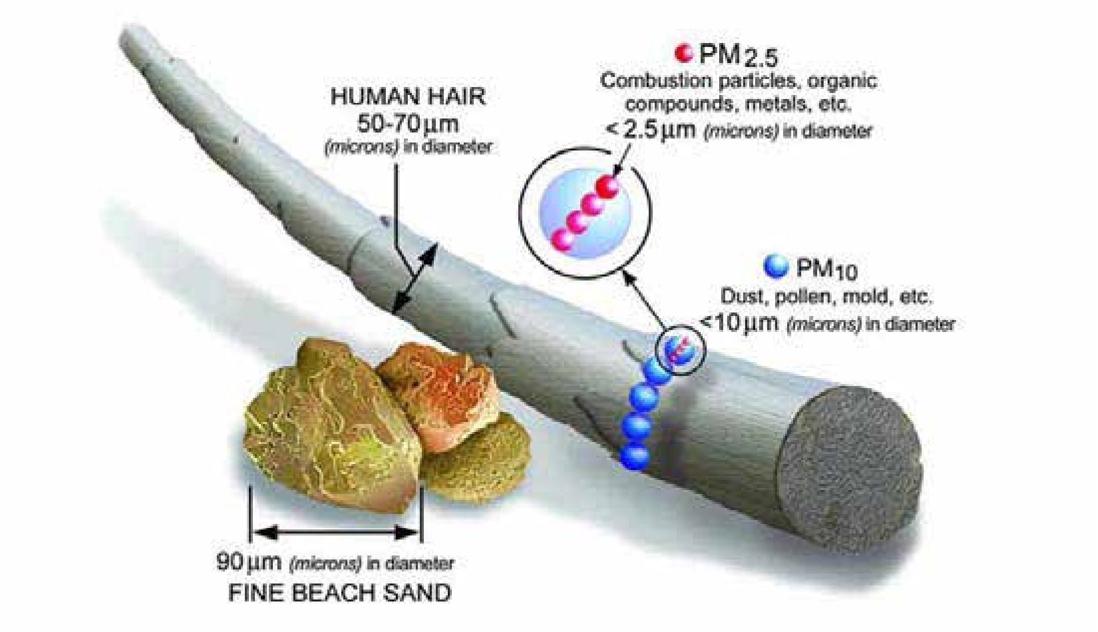


Figure 2 Particulate matter (reproduced with permission from the USEPA, Office of Research and Development)

Examples of particles in ambient air include dust, smoke, plant spores, bacteria and sea salt (marine aerosol). In addition to health impacts, particle pollution also reduces visual amenity, reduces visibility and soils surfaces.

Sources

Human-made sources include mining, combustion of fuels, transportation, agricultural and hazard reduction burning, incinerators and residential wood heaters.

Health

The size of a particle determines its potential impact on human health. Larger particles are usually trapped in the nose and throat while smaller particles may reach the lungs. Fine particles can be carried deep into the lungs and irritate the airways.

Current medical research shows that particle pollution can exacerbate existing respiratory symptoms such as asthma and chronic bronchitis, and at high concentrations cause respiratory symptoms. Particles can also adversely impact cardiovascular health. People with heart or lung diseases, children and older adults are the most likely to be affected by exposure to particle pollution.

Particulate matter <2.5µm ($PM_{2.5}$)

Characteristics

$PM_{2.5}$ refers to all particles with an aerodynamic equivalent diameter less than 2.5 micrometres (2.5 µm). Health evidence identifies $PM_{2.5}$ as the air pollutant of greatest concern.

Sources

Combustion sources such as road transport, non-road equipment and transport, residential wood heaters and coal-fired electricity generation are major sources of $PM_{2.5}$ emissions, along with fugitive emissions from coal mines. Coal mines and residential wood heaters are the two largest sources of $PM_{2.5}$ emissions in the GMR, whereas the largest source in Sydney is residential wood heaters.

Standards and measured levels

The Ambient Air Quality NEPM prescribes ambient air advisory reporting standards for $PM_{2.5}$ of 25 micrograms per cubic metre (µg/m^3) as a 24-hour average and 8 µg/m^3 as an annual average.

Current air quality in NSW (DECCW 2010) shows that Sydney experiences a relatively low number of exceedances of the 24-hour average Ambient Air Quality NEPM standard per year. Less than 5 exceedance days (where concentrations in ambient air at one or more air quality monitoring stations are above the Ambient Air Quality NEPM standard) per year have been recorded since 2004, except in 2009 where the dust storms caused a higher number of exceedances. The annual average Ambient Air Quality NEPM standard has been exceeded at one to two monitoring station in some years, with maximum annual average concentrations of 10 µg/m^3 or less.

Particulate matter <10µm (PM_{10})

Characteristics

PM_{10} refers to all particles with an aerodynamic equivalent diameter less than 10 micrometres (10 µm), and hence also includes $PM_{2.5}$.

Sources

Coal mines and marine aerosol (sea salt) are the two largest sources of PM_{10} emissions in the GMR, whereas the largest source in Sydney is residential wood heaters. Natural sources such as marine aerosol (sea salt), bushfires and prescribed burning, and windblown dust account for about a quarter of all PM_{10} emissions in the GMR and Sydney.

Standards and measured levels

The Ambient Air Quality NEPM prescribes an ambient air standard for PM_{10} of 50 micrometres (µg/m^3) as a 24-hour average, with no more than five exceedances per year.

Current air quality in NSW (DECCW 2010) shows that Sydney experiences exceedances of the PM_{10} ambient air standard most years, with highest concentrations occurring during dust storm and bushfire events.

Total suspended particles

Characteristics

Total suspended particles (TSP) includes all particles that remain airborne for a time period of the order of minutes to hours, and typically refer to particles with a maximum size of approximately 30 µm.

Standards and measured levels

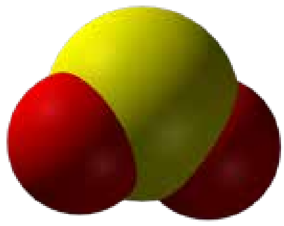
There is no prescribed Australian ambient air standard for TSP.

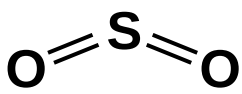
TSP is now used as a metric for assessing amenity impacts (reduction in visibility, dust deposition and soiling of buildings and surfaces) rather than health impacts.

Sulfur dioxide

Characteristics

Sulfur dioxide (SO_2) is a colourless gas with a pungent irritating smell. SO_2 emissions can mix with water vapour to form acids (acid rain) that can damage vegetation, alter the mineral content in soils, and corrode materials. SO_2 emissions also contribute to the formation of secondary inorganic particles in the atmosphere. The molecular structure of SO_2 is shown below.





Sources

SO_2 is primarily formed by combustion of sulfur-containing fuels such as coal and petroleum products. The major sources of SO_2 emissions in both the GMR and Sydney are EPA-licensed industry premises.

Health

Current scientific evidence links short-term exposure to SO_2 (ranging from 5 minutes to 24 hours) with an array of adverse respiratory effects including broncho-constriction and increased asthma symptoms. These effects are particularly important for asthmatics while exercising or playing. Studies show a connection between short-term exposure and increased visits to emergency departments and hospital admissions for respiratory illnesses, particularly in at-risk populations including children, the elderly, and asthmatics.

The contribution of SO_2 to the formation of secondary particles also adds to the health impact of particle pollution.

Standards and measured levels

The Ambient Air Quality NEPM prescribes ambient air standards for SO_2 of 0.2 ppm as a 1-hour average, 0.08 ppm as a 24-hour average, and 0.02 ppm as an annual average.

Elevated concentrations of SO_2 in ambient air are generally associated with coal-fired electricity generation. Since vehicle fuels in NSW are relatively low in sulfur, ambient concentrations are generally low in urban areas.

Current air quality in NSW (DECCW 2010) shows that ambient SO_2 levels are below the Ambient Air Quality NEPM standards. No exceedances of the Ambient Air Quality NEPM standards for SO_2 have been measured in NSW for 20 years.

Total volatile organic compounds

Characteristics

The Protection of the Environment Operations (Clean Air) Regulation 2010 defines volatile organic compounds (VOC) based on their vapour pressure (>0.27 kPa) at 25°C and 101.3 kPa, but VOC can simply be considered as the sum of hydrocarbons (excluding methane) and oxygenated hydrocarbons.

Sources

VOC are emitted by a wide range of both natural and human-made sources including trees and grass, aerosols and solvents, paints, road transport and residential wood heaters. Sources for individual organic compounds are discussed in later sections.

Health

VOC have a range of health impacts including irritation of the eyes, nose and throat, headaches, and damage to the organs and central nervous system. Some VOC compounds are known or suspected carcinogens.

In addition to their direct adverse health effects, many VOC play a key role in atmospheric photochemical reactions that form both ground-level ozone and secondary particles.

Standards and measured levels

There is no prescribed Australian ambient air standard for VOC.

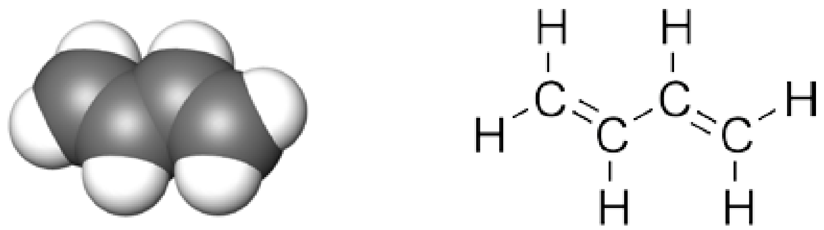
Some guidelines are set for individual compounds by international organisations such as the World Health Organisation and the United States Environmental Protection Agency.

Ambient air quality monitoring in NSW focuses on specific organic compounds rather than total VOCs. You can download the EPA Air Toxics Study or the 2009–2010 NEPC annual report for more information about specific organic compounds in ambient air.

1,3-Butadiene

Characteristics

1,3-butadiene is a highly reactive VOC and is a precursor to photochemical smog formation. It is a colourless gas at ambient conditions with a slight petrol-like aroma. Due to its reactivity, 1,3-butadiene exists in the atmosphere for only a few hours. Its chemical formula is C_4H_6 and its molecular structure is shown below.



Sources

1,3-butadiene is most commonly emitted as a combustion product from petrol vehicles, residential wood heaters and bushfires. Petrol vehicles are the largest source of 1,3-butadiene emissions in the GMR and Sydney followed by residential wood heaters. 1,3-butadiene is also used in the production of synthetic rubbers and plastics.

Health

Exposure to the gas can irritate the eyes, nose and throat. Long term exposures at lower levels have shown increases in heart and lung damage.

The International Agency for Research on Cancer (IARC) and the United States Environmental Protection Agency (USEPA) classify 1,3-butadiene as group 1 ‘carcinogenic to humans’ and A ‘human carcinogen’.

In addition to its direct adverse health effects, 1,3-butadiene plays a key role in atmospheric photochemical reactions that form both ground-level ozone and secondary particles.

Standards and measured levels

There is no prescribed Australian ambient air standard for 1,3-butadiene.

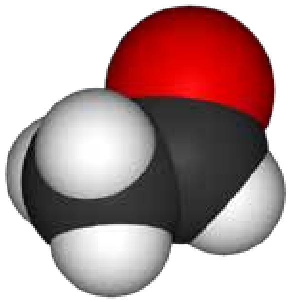
The United Kingdom prescribes an ambient air standard for 1,3-butadiene of 1 ppb as an annual average.

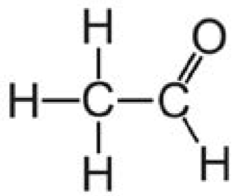
Monitoring of 1,3-butadiene in ambient air at five sites in Sydney in 2006, and at two sites in 2008-2009 (NEPC, 2010) , found levels of less than 0.1 ppb, down from levels of 0.2 ppb measured in the EPA Air Toxics Study over the period 1996-2001. While Australia does not have an ambient air standard, these levels are below the United Kingdom ambient air standard.

Acetaldehyde

Characteristics

Acetaldehyde is a reactive VOC and is precursor to photochemical smog formation. It is a clear colourless fuming liquid with a pungent, fruity odour, with a boiling point of 21°C. Its chemical formula is C_2H_5O and its molecular structure is shown below.





Sources

The largest source of acetaldehyde emissions in the GMR and Sydney is from pasture and mown grass, with residential wood heaters and internal combustion engines (road transport, and non-road equipment and transport) also making significant contributions.

Health

Acetaldehyde is an irritant of the skin, eyes, mucous membranes, throat and respiratory tract.

The IARC and the USEPA classify acetaldehyde as group 2B ‘possibly carcinogenic to humans’ and B2 ‘Probable human carcinogen – based on sufficient evidence of carcinogenicity in animals’.

In addition to its direct adverse health effects, acetaldehyde plays a key role in atmospheric photochemical reactions that form both ground-level ozone and secondary particles.

Standards and measured levels

There is no prescribed Australian ambient air standard for acetaldehyde.

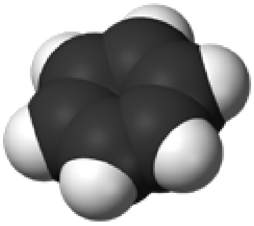
The USEPA has determined a reference concentration (RfC) (estimate of a continuous inhalation exposure to the human population including sensitive subgroups that is likely to be without an appreciable risk of deleterious effects during a lifetime) for acetaldehyde of 5 ppb for non-carcinogenic effects.

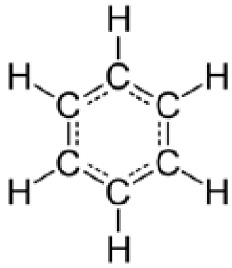
Monitoring of acetaldehyde levels in ambient air at five sites in Sydney in 2006, and at two sites in 2008-2009, found levels of around 0.5 ppb. While Australia does not have an ambient air standard, this level is below the USEPA RfC, a level that is defined to have no adverse health impacts over a lifetime exposure.

Benzene

Characteristics

Benzene is a clear pale yellow liquid VOC with an aromatic odour and is a precursor to photochemical smog formation. It is an aromatic organic compound with the chemical formula C_6H_6 and its molecular structure is shown below.





Sources

Benzene occurs naturally in fossil fuels and is produced incidentally in the course of natural processes and human activities that involve the combustion of organic matter such as wood, coal and petroleum products.

In urban areas, road transport and other internal combustion engines are the largest source of benzene emissions along with residential wood heaters. The production of coking coal for use in steel manufacturing is also a large source.

Health

Exposure can result in symptoms such as skin and eye irritations, drowsiness, dizziness, headaches and vomiting. Long-term exposure at various levels can affect normal blood production.

The IARC and the USEPA classify benzene as group 1 'carcinogenic to humans' and A ‘human carcinogen’. It is linked to various forms of leukaemia.

In addition to its direct adverse health effects, benzene plays a role in atmospheric photochemical reactions that form both ground-level ozone and secondary particles.

Standards and measured levels

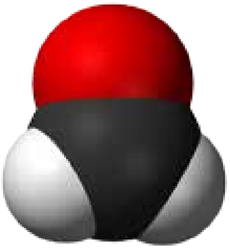
The Air Toxics NEPM prescribes a monitoring investigation level (MIL) (concentration which requires further investigation and evaluation) in ambient air for benzene of 3 ppb as an annual average.

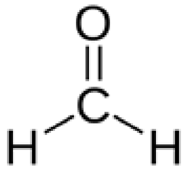
Monitoring of benzene levels in ambient air at five sites in Sydney in 2006, and at two sites in 2008–2009 (NEPC, 2010), found levels in the range of 0.2–0.5 ppb. These levels are below the Air Toxics NEPM MIL.

Formaldehyde

Characteristics

Formaldehyde is colourless gas with a pungent odour (above 1 ppm concentration) and is a precursor to photochemical smog formation. Its chemical formula is C_1H_2O and its molecular structure is shown below.





Sources

Formaldehyde is emitted by combustion sources, including residential wood heaters. Non-road diesel equipment and transport is the largest source of formaldehyde emissions in the GMR. In Sydney, residential wood heaters are the largest source of formaldehyde emissions. It is also emitted by petrol and diesel vehicles, commercial business and EPA-licensed industry premises such as petroleum manufacturing and printing, and from aerosols and solvents.

Health

Exposure to low levels of formaldehyde irritates the eyes, nose and throat, and can cause allergies affecting the skin and lungs.

The IARC classifies formaldehyde as group 1 'carcinogenic to humans' for the relatively rare nasopharyngeal cancer and strong but not sufficient evidence associating formaldehyde with leukaemia. The USEPA classifies formaldehyde as class B1 'probable human carcinogen – based on limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in animals'.

In addition to its direct adverse health effects, formaldehyde plays a key role in atmospheric photochemical reactions that form both ground-level ozone and secondary particles.

Standards and measured levels

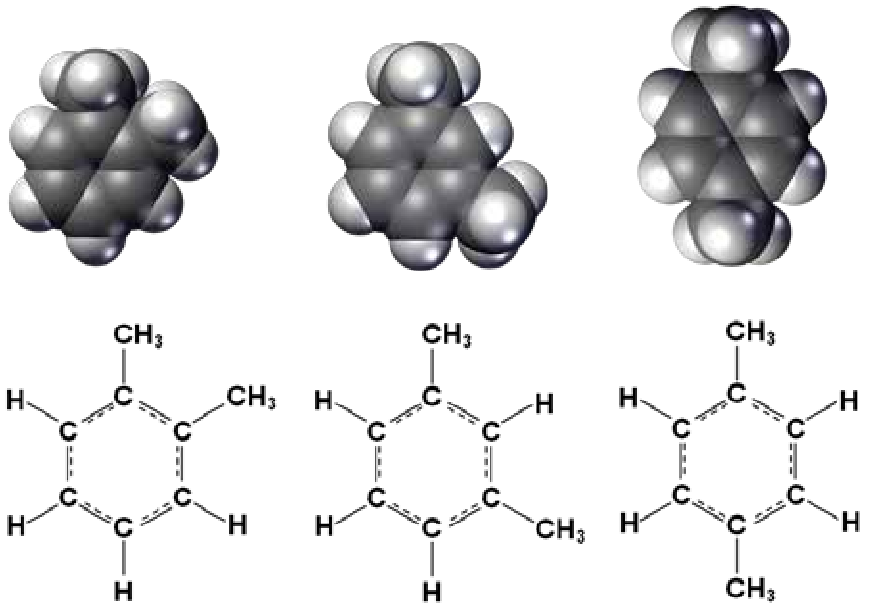
The Air Toxics NEPM prescribes a monitoring investigation level (MIL) (concentration which requires further investigation and evaluation) in ambient air for formaldehyde of 40 ppb as a 24-hour average.

Monitoring of formaldehyde levels in ambient air at five sites in Sydney in 2006, and at two sites in 2008–2009 (NEPC, 2010), found levels in the range of 2–3 ppb. These levels are below the Air Toxics NEPM MIL.

Xylenes

Characteristics

Xylenes are a clear colourless liquid with a strong sweet odour and are a precursor to photochemical smog formation. Xylene is an aromatic organic compound with one aromatic ring and two methyl groups, and a chemical formula of C_8H_{10}. As the methyl groups can attach to different relative positions on the aromatic ring, it can exist in three molecular structures called isomers. These are shown below.



o-xylene *m*-xylene *p*-xylene

Sources

Xylenes are a common solvent VOC used in paint and other chemical manufacture, and are also present in petrol at around 10 per cent by volume. Xylenes exist in ambient air as a mixture of ortho, meta and para isomers.

The largest sources of xylenes emissions in the GMR are from paint and surface coating use, and petrol-fuelled motor vehicles and other petrol engines. Smaller contributors include residential wood heaters, service stations, printing and non-road equipment and transport.

In addition to their direct adverse health effects, xylenes play a key role in atmospheric photochemical reactions that form both ground-level ozone and secondary particles.

Health

Xylenes are an irritant to the nose eyes and throat, and are highly reactive in photochemical smog formation chemistry. They may cause stomach problems, drowsiness, loss of memory, poor concentration, nausea, vomiting, abdominal pain and incoordination.

The IARC classifies xylenes as group 3 ‘not classifiable as to its carcinogenicity to humans’

Standards and measured levels

The Air Toxics NEPM prescribes monitoring investigation levels (MIL) (concentration which requires further investigation and evaluation) in ambient air for xylenes of 0.25 ppm as a 1-hour average and 0.20 ppm as an annual average.

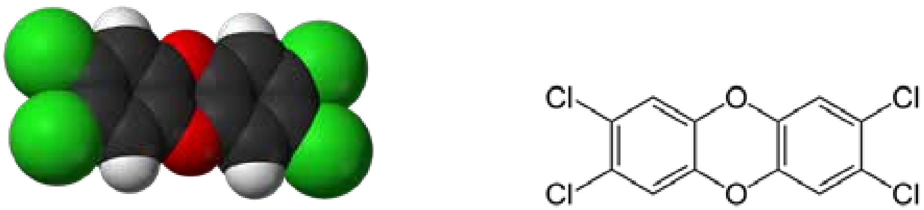
Monitoring of xylenes levels in ambient at five sites at Sydney in 2006, and at two sites in 2008-2009 (NEPC, 2010), found levels in the range of 0.2–1.4 ppb. These levels are below the Air Toxics NEPM MILs.

Polychlorinated dioxins and furans

Characteristics

Dioxins and furans refer to a large group of chlorinated chemical compounds, polychlorinated dibenzo-*p*-dioxins (PCDDs) and the closely related polychlorinated dibenzofurans (PCDFs), which share certain similar physical, chemical and biological properties, including toxicity. PCDDs and PCDFs are white crystalline solids at room temperature. PCDDs and PCDFs are classified as persistent organic pollutants (POP) due to their very long life in the environment and consequent bioaccumulation in the food chain.

Due to its toxicity the principal congener of concern is 2,3,7,8-tetrachlorodibenzon-*p*-dioxin (2,3,7,8-TCDD) which has a chemical formula $C_{12}H_4Cl_4O_2$. Its chemical structure is shown below.



2,3,7,8-TCDD

Fifteen congeners have been assessed to have significant biological toxicity and are assigned toxic equivalence factors (TEF) relative to the most toxic, 2,3,7,8-TCDD, which has a TEF of 1. The toxicity of mixtures of various dioxins and furans is defined by a toxic equivalence quotient (TEQ) which is calculated as a sum of the mass of each dioxin or furan multiplied by its TEF.

Sources

PCDDs and PCDFs are generated as by-products from various combustion and chemical processes. PCDDs and PCDFs are produced during incomplete combustion of chlorine containing wastes like municipal solid waste, sewage sludge, and hospital and hazardous wastes. Various metallurgical processes involving heat, and burning of coal, wood, petroleum products and used tires for energy generation also generate PCDDs and PCDFs.

The largest sources of PCDD and PCDF emissions in the GMR are coal-fired electricity generation, non-road equipment and transport, residential wood heaters and metal manufacturing. In Sydney, the largest sources of PCDD and PCDF emissions are residential wood heaters, air transport and diesel engine exhaust.

Health

Short-term exposure of humans to high levels of PCDD and PCDF may result in skin lesions, such as chloracne and patchy darkening of the skin, and altered liver function. Long-term exposure is linked to impairment of the immune system, the developing nervous system, the endocrine system and reproductive functions.

Chronic exposure of animals to PCDD and PCDF has resulted in several types of cancer.

The IARC and the USEPA classify 2,3,7,8-TCDD as group 1 ‘carcinogenic to humans’ and B2 ‘probable human carcinogen – based on sufficient evidence of carcinogenicity in animals’.

Food is the main source of human intake of PCDDs and PCDFs, while inhalation exposure to PCDDs and PCDFs is generally low.

Standards and measured levels

There is no prescribed Australian ambient air standard for PCDDs and PCDFs.

The EPA Air Toxics Study measured dioxin levels in NSW at three sites over 1996 to 2001. Concentrations were found to be well below international benchmarks.

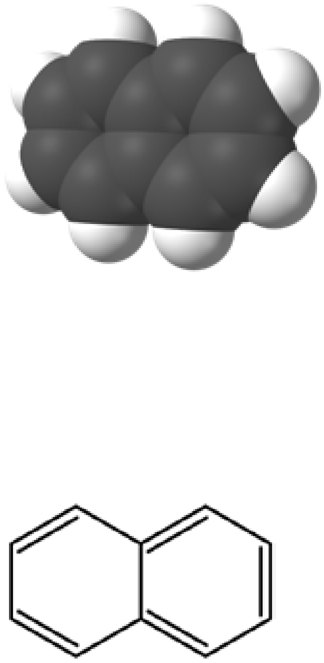
A further monitoring program was conducted over 12 months in 2002–2003 at Westmead in Sydney as part of the National Dioxins Program (NEPC 2001). An annual average concentration of 15 x 10^{-9} $\mu g/m^3$ (TEQ) was measured, and this level was found to be low in a comparison to dioxin levels in international cities.

Polycyclic aromatic hydrocarbons

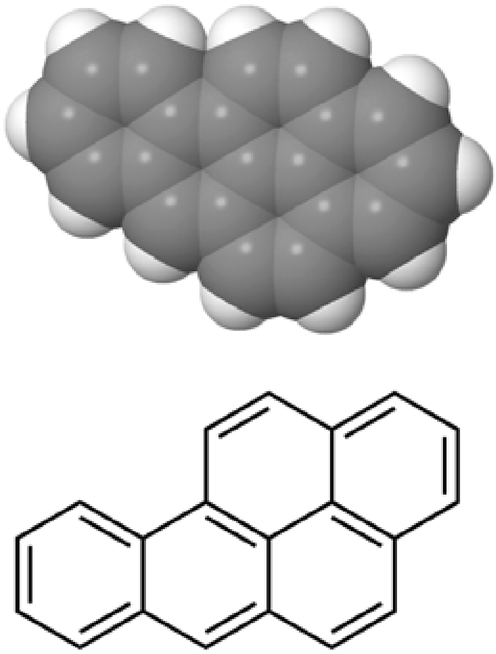
Characteristics

Polycyclic aromatic hydrocarbons (PAH) are a group of over 100 compounds comprising of two or more aromatic (benzene) rings with or without various substituted groups (methyl, ethyl, etc.). PAH are solid at room temperature and primarily exist in ambient air adsorbed onto particulate matter ($PM_{2.5}$ and PM_{10}).

Naphthalene, a two-ring PAH, is the dominant PAH compound in total PAH emissions (around 40 per cent of road transport and residential wood heater total PAH). The chemical formula of naphthalene is $C_{10}H_8$ and its molecular structure is shown below. Benzo(a)pyrene is a carcinogenic five-ring PAH that is often used as a marker for PAH. Its chemical formula is $C_{20}H_{12}$, and its molecular structure is also shown below.



Naphthalene



Benzo(a)pyrene

Sources

PAHs are formed by the incomplete combustion of coal, oil, petrol, wood, tobacco, charbroiled meats, or other organic materials. Typically much of the PAH emitted from combustion sources is absorbed onto the particulate matter.

In the GMR the largest source of PAH emissions is residential wood heaters, followed by aerosols and solvents (a source of naphthalene from mothballs), petrol and diesel engines, and steel production.

Health

Exposure can irritate the eyes, nose, throat and bronchial tubes. Skin contact can cause irritation or a skin allergy.

The IARC classifies a number of PAH as either a group 1 ‘carcinogenic to humans’, group 2A ‘probably carcinogenic to humans’, or group 2B ‘possibly carcinogenic to humans’.

Naphthalene, the major component in total PAH, is classified as a group 2B 'possibly carcinogenic to humans’ by IARC and C ‘possible human carcinogen’ by the USEPA.

Benzo(a)pyrene, which is present in much lower concentrations in total PAHs, is listed as a group 1 ‘carcinogenic to humans’ by IARC and B2 ‘probable human carcinogen – based on sufficient evidence of carcinogenicity in animals’ by the USEPA.

Standards and measured levels

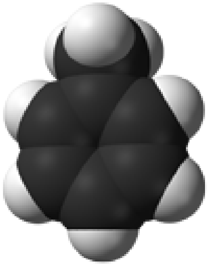
The Air Toxics NEPM prescribes a monitoring investigation level (MIL) (concentration which requires further investigation and evaluation) in ambient air for benzo(a)pyrene of 0.3 nanograms per cubic metre (ng/m^3) as an annual average.

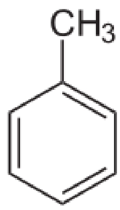
Monitoring of PAH levels in ambient at two sites in Sydney in 2008–2009 (NEPC, 2010), found annual average levels of 1.54 ng/m^3 for naphthalene and 0.21 ng/m^3 for benzo(a)pyrene. This level is below Air Toxics NEPM MIL.

Toluene

Characteristics

Toluene is an aromatic organic compound that is a clear liquid at ambient temperatures, with the smell of paint thinners and is a precursor to photochemical smog formation. Its chemical formula is C_7H_8 and its molecular structure is shown below.





Sources

Toluene is a common solvent used in paint and other chemical manufacture, and is also present in petrol at around 15–20 per cent by volume.

The largest sources of toluene emissions in the GMR are from paint and surface coating use, petrol vehicles and engines, and aerosol and solvent use.

Health

Toluene causes respiratory irritation and is a central nervous system depressant. However these effects are associated with workplace exposure levels, which are orders of magnitude higher than ambient air concentrations.

The IARC classifies toluene as a group 3 ‘Not classifiable as to its carcinogenicity to humans’.

In addition to its direct adverse health effects, toluene plays a key role in atmospheric photochemical reactions that form both ground-level ozone and secondary particles.

Standards and measured levels

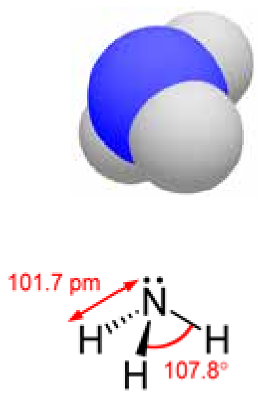
The Air Toxics NEPM prescribes monitoring investigation levels (MIL) (concentration which requires further investigation and evaluation) in ambient air for toluene of 0.1 ppm as an annual average and 1 ppm as a 24-hour average.

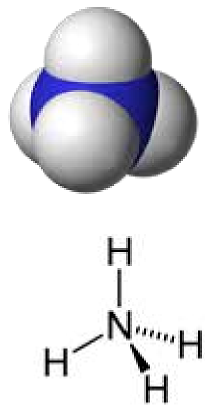
Monitoring of toluene levels in ambient at five sites at Sydney in 2006, and at two sites in 2008–2009 (NEPC, 2010), found levels in the range of 0.5–2.0 ppb. These levels are below the Air Toxics NEPM MILs.

Ammonia

Characteristics

Ammonia (NH_3) is a colourless gas with a conspicuous, pungent odour that is distinctive of drying urine. Ammonia in the air emissions inventory refers to the mixture of two different, but related compounds: ammonia (NH_3) and the ionised form (NH_4^+), commonly called total ammonia. Their molecular structures are shown below.





Sources

Ammonia is released from soil both naturally and as a result of ammonia based fertiliser application. It is also generated by the catalyst fitted to petrol-fuelled vehicles when running rich, and from poultry farming.

The largest source of NH_3 emissions in the GMR are agriculture, soil, petrol vehicles, waste disposal and composting, and fertiliser manufacture.

Health

Exposure to typical environmental concentrations of ammonia will not affect humans. Exposure to high levels of ammonia can cause irritation and serious burns on the skin, and in the mouth, throat (laryngitis), lungs (pulmonary oedema) and eyes (conjunctivitis).

Ammonia reacts in the atmosphere with NO_x and sulfur compounds to form secondary inorganic particulate matter known as nitrates and sulfates. These secondary particles can contribute to total particulate matter ($PM_{2.5}$ and PM_{10}) and hence to human health impacts.

Standards and measured levels

There is no prescribed Australian ambient air standard for ammonia.

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