CleanRun Remote Sensor: On-Road Vehicle Emissions Testing

Facts about the CleanRun Remote Sensor and vehicle emissions

The CleanRun RS is a machine that detects vehicle emissions when a car drives through an invisible light beam which is being projected across the roadway.

The CleanRun RS is a practical approach for determining on-road vehicle emissions.

The CleanRun RS can determine fleet average emissions for inventory purposes.

The CleanRun RS can characterize fleet emissions distributions to evaluate control programs.

Purpose

The Department of Environment and Conservation (DEC) is undertaking CleanRun Remote Sensor (CleanRun RS) testing to determine the emission performance of the Western Australian vehicle fleet.

The majority of vehicle air pollution emissions in the Perth air-shed will come from a small percentage of high emitting vehicles on Perth roads. The number equates to approximately 10 per cent of the vehicle population.

By understanding the emission performance of a range of vehicles in our fleet, DEC can develop programs aimed at reducing vehicle emissions. The information will also allow DEC to inform the community about their vehicle's emission performance and what can be done to help reduce those emissions.

This Air Quality Information Sheet (AQIS) has been developed by the DEC to provide information to the community on:

- how the CleanRun RS measures vehicle emissions on our roads
- the role of the CleanRun RS in managing air quality in WA.

CleanRun RS measuring vehicle emissions in Balcatta

Scope

The information in this AQIS will be of particular use to individuals who wish to learn more about vehicle emissions management in WA, and the use of the CleanRun RS on our roads. The information will also be of interest to people seeking general information on key sources and potential impacts of air pollution in WA. A glossary is included at the back of the document to define key air pollution terms used in this AQIS.

Units similar to the CleanRun RS are used widely in the United States to control vehicle emissions through inspection and maintenance programs.

CO is an invisible air pollutant which is poisonous to humans.

NO_x and air toxics (e.g. hydrocarbons) react with sunlight to create a secondary air pollutant called ozone, which can have negative health and vegetation impacts on the surrounding community.

What air pollution is produced by motor vehicles?

Motor vehicles produce the following air pollutants:

- Carbon monoxide (CO)
- Nitrogen oxides (NO_x) (e.g. nitric oxide NO)
- Volatile Organic Compounds (VOCs)
- Particulate Matter (PM_{10} and $PM_{2.5}$ — particulate matter with an equivalent aerodynamic diameter of 10µm or 2.5µm respectively)
- Air toxics, including benzene, toluene, polycyclic aromatic hydrocarbons (PAH's) and xylenes.
- Lead (levels in WA very low due to reduced lead fuel content in fuel since 2000)

Motor vehicles also produce the following greenhouse gases:

- Carbon dioxide (CO_2)
- Halocarbons (e.g. chloroflurocarbons)
- Hydroflurocarbons (HFCs)
- Nitrous oxide (N_2O)
- Ozone (O_3).

How does the CleanRun RS measure vehicle emissions?

The CleanRun RS sends an infrared (IR) and ultraviolet (UV) light beam across a single lane of road. Fuel specific concentrations of hydrocarbons, carbon monoxide, carbon dioxide (CO_2), nitrogen oxide (NO) and smoke are measured in vehicle exhaust plumes based on the absorption of IR and UV in the light beam produced from the CleanRun RS. The CleanRun RS can measure 50 samples in under a second and only samples with more than 10 per cent valid readings are included in the calculations.

The factors that are recorded during this process include:

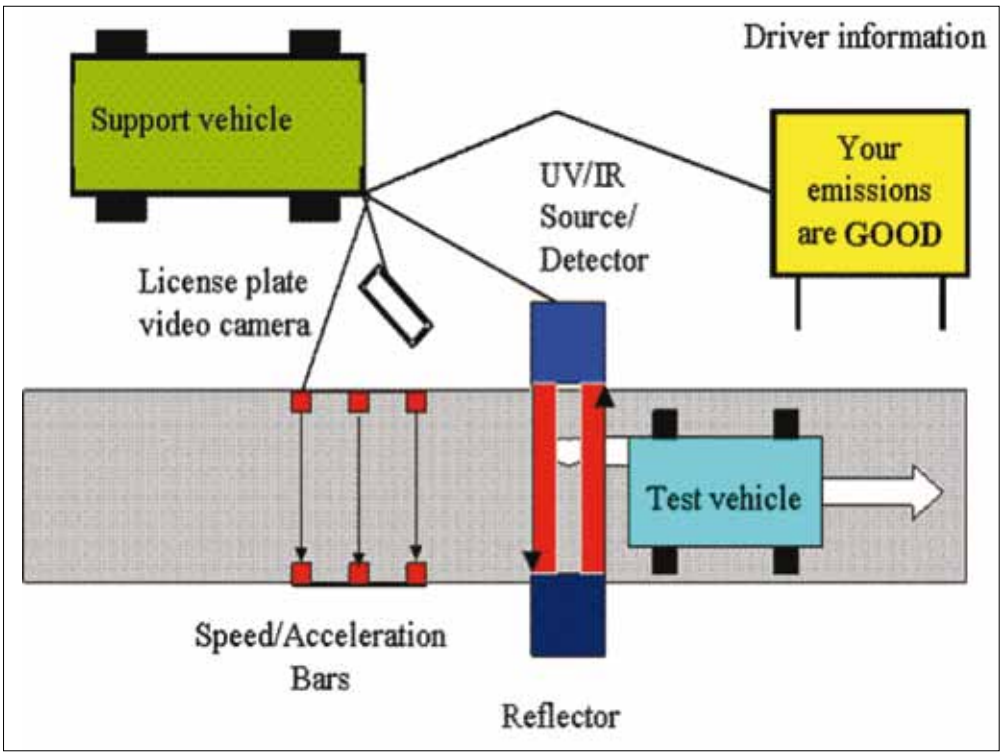
- speed
- acceleration
- vehicle's licence plate number*
- UV beam measures smoke and NO from vehicle
- IR beam measures HC, CO and CO_2 from vehicle.

*Note: only the vehicles type, age and fuel type are retrieved from the Department of Transport. No personal or identifying information is provided.

From 2000-2001, motor vehicles were the largest source of NOx and CO, and a major source of PM10 in the Perth "air shed" region.

Particulate matter produced from diesel vehicles can have negative health impacts, including increased levels of mortality.

Diesel exhaust fumes include nitric oxide, sulfur dioxide, hydrocarbons, and carbon monoxide.



The above diagram demonstrates the typical CleanRun RS set-up on a single lane roadway. A digital information sign is attached to the CleanRun RS which show the "test vehicle" emissions performance results after they pass through the testing equipment.

The digital information sign will provide you with an assessment of your vehicle's emission performance if you pass through the CleanRun RS. The following table summarises the parameters that are used to classify your vehicle performance after passing through the CleanRun RS. The computer calculates vehicle emissions performance based on the parameters in the flow chart then displays the result on the digital information sign.

Most of the air pollution in Perth is produced from motor vehicle emissions in the summer months.

Motor vehicles also produce evaporative emissions, which are fuel vapours produced from unburnt fuel.

Technical advances in vehicle technology and the production of cleaner fuels have led to a reduction in the amount of air pollution produced by motor vehicles in the last few decades.

Vehicle Performance	CO	NO	Total Hydrocarbons	Smoke
GOOD	< 0.69%	<1545 ppm	<198 ppm	<0.07
FAIR	0.70% to 3.16%	1546 to 3251 ppm	199 to 577 ppm	0.08 to 0.21
POOR	>3.17%	>3252 ppm	>578 ppm	>0.22

* ppm = parts per million

If your vehicle passes through the CleanRun RS and does not register on the digital information sign, it is because insignificant emissions were recorded from the exhaust plume. This could be due to a numbers of factors including deceleration, coasting or climatic conditions (winds, humidity).

What do the results mean?

If your vehicle received a fair or poor reading for a pollutant, it may mean it's not running as efficiently as it should and may need to be checked for faults. It may also mean that your car was under load or heavy acceleration at the time of the reading, which will also increase emissions. It is recommended that your vehicle undergoes regular servicing to improve the vehicle performance and reduce emissions.

Poor readings what do they mean?

- A high carbon monoxide reading may point to a problem with the fuel delivery system i.e. carburettor or fuel injection system.
- A high total hydrocarbons reading is the result of unburned fuel passing through the exhaust and is often related to problems in the ignition system.
- A high nitric oxide reading may be caused by a faulty exhaust gas recirculation system or malfunctioning catalytic converter.

What are the objectives of the CleanRun RS program?

DEC is undertaking this testing to determine the emission performance of Perth's vehicle fleet. By understanding the emission performance of a range of vehicles in our fleet we can develop programs aimed at reducing vehicle emissions.

How can I become involved?

DEC plans to inform the community about their vehicle's emission performance and what can be done to help reduce their vehicle emissions through community days which will have the CleanRun RS in operation. Throughout the year DEC will be holding community education days. To find out when and where the next event is being held visit http://www.dec.wa.gov.au/cleanrun . On offer will be:

- A free emissions check to give you an idea of the emissions performance of your vehicle
- An on-site, free vehicle 'health-check' by qualified mechanics for vehicle owners who have passed through the emission sensors and who would like to know what they can do to improve their emissions performance
- A free information kit containing your vehicle test results and information on how to improve the performance of your vehicle
- Information on CleanRun and how you can become involved in improving air quality

In early 2011, DEC is launching the CleanRun Ecodrive Program, which is aimed at improving air quality in WA by encouraging local vehicle fleets to modify their driving behavior.

Changes in driving behaviour promoted through the Ecodrive program, can reduce air pollution emissions, carbon footprint, fuel costs, vehicle maintenance and reduce accidents on the roads.

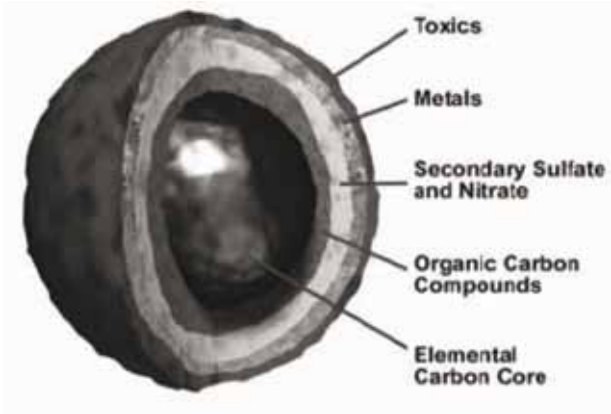
In this current testing program in 2010-2011, DEC is aiming to test 20,000 vehicles at various sites around Perth. DEC will be revisiting sites in the coming years to determine any trends in the emission performance of the vehicle fleet. The data we are collecting will be used to help refine estimates of vehicle emissions and look at the differences in emissions by vehicle age, fuel type and engine size.

What are the health impacts from vehicle emissions?

Health: Motor vehicle emissions can cause numerous health problems and aggravate chronic respiratory conditions. Particulates from diesel vehicle emissions (see diesel particle diagram below) can lodge in the lungs, which can result in lung and heart disease. CO emissions can cause dizziness, confusion, headaches and in high concentrations lead to death. NO_x can restrict the respiratory system in humans. VOCs can react with NO_x and sunlight to create ozone, which can also cause respiratory conditions in people (e.g. coughing, chest-tightness). Air toxics (e.g. benzene, PAHs) include substances that can cause cancer and organ damage in humans, and have toxic impacts on natural environments[1].

Vegetation and crops: Air pollution can restrict processes enabling vegetation and crops to grow (e.g. photosynthesis) and contribute to the premature death of vegetation. Smoky vehicle emissions are not currently managed by government for vegetation impacts.[3]

Visibility: Motor vehicle emissions can contribute to the formation of photochemical smog, and brown 'winter haze' above Perth which can reduce visibility (See AQIS 1).



Diesel particle composition[2]

Recommendations: How can you reduce air pollution from your vehicle?

Smoky vehicles and other exhaust emissions have negative impacts on human health and environment. You can help reduce vehicle emissions on our roads by the following.

1. Ensure your personal vehicle is regularly maintained and serviced to reduce air pollution emissions.
2. Consider altering your driving style to reduce your air pollution emissions, and become an 'eco-driver'. This includes avoiding harsh acceleration/deceleration and unnecessary engine idling which can contribute to increased vehicle emissions.
3. When purchasing a new motor vehicle consider those with stricter technology standards as required under the Australian Design Rules (ADR). A list of low emission vehicles is available at the Green Vehicle Guide which is an Australian government website: http://www.greenvehicleguide.gov.au
4. If you own a modern motor vehicle, consider purchasing high octane fuels at the petrol station, which will reduce harmful emissions from your vehicle and improve fuel economy.
5. Report smoky vehicles on the road in WA through the Smoky Vehicle Hotline at DEC:
    a. Telephoning +61-8-9324 2835 or Freecall 1800 0SMOKY (1800 076 659) - 24 hour recorded service
    b. Fax (08) 9333 7450
    c. E-mailing smokyvehicles@dec.wa.gov.au
    d. Use the smoky vehicle reporting booklet – request one by e-mailing smokyvehicles@dec.wa.gov.au
    e. See AQIS 2 for further information on the smoky vehicle program.

More Information?

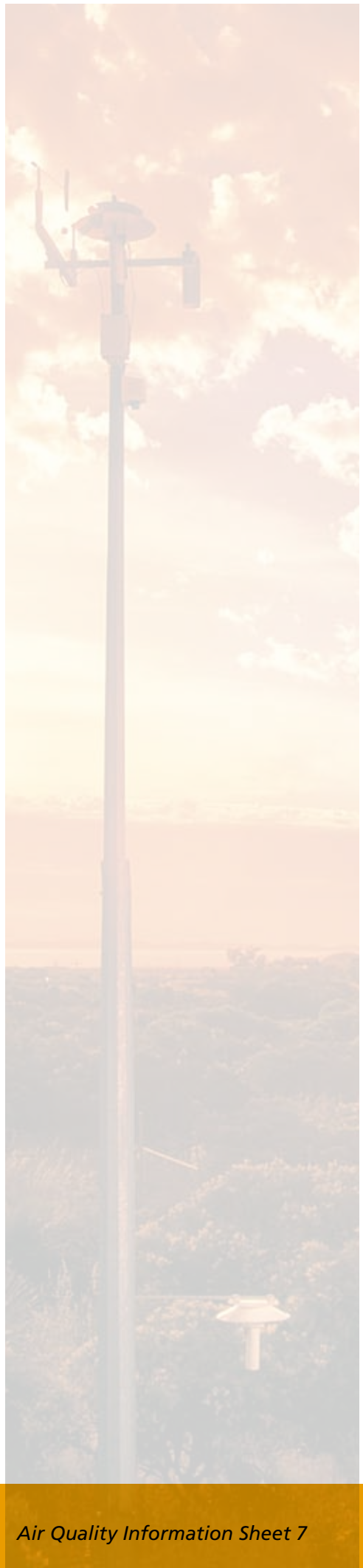
For further information related to this topic and ways you can reduce your air pollution emissions please read the following publications on the DEC website at http://www.dec.wa.gov.au:

- ***AQIS 1: Wood heaters and air pollution: reducing smoke emissions***
- ***AQIS 2: Smoky vehicles and the ten-second rule***
- ***AQIS 3: Wood heater compliance requirements***
- ***AQIS 4: Unflued gas heaters and indoor air quality***
- ***AQIS 5: Firewood restrictions and air quality in Western Australia***

With the further development of AQIS, additional information on air pollution issues affecting Perth and Western Australia will be published on the DEC website.

To comment on this AQIS or for more information, please contact the Air Quality Management Branch at our Perth offices on (08) 9333 7436 or email airquality@dec.wa.gov.au citing the AQIS topic and version.

The AQIS recommendations do not override any statutory obligation or Government policy statement on air pollution control. Alternative practical environmental solutions to suit local conditions may be considered. Also this AQIS shall not be used as this Department's policy position on a specific matter, unless confirmed in writing.



REFERENCES

1. California Air Resources Board (CARB). 2005. Wood Burning Handbook: Protecting the Environment and Saving Money. California: Cal/EPA Air Resources Board
2. Rumchev, K & B. Mullins. 2010. Diesel Particulate Matter: An Emerging Hazard in WA? Clean Air Society of Australia and New Zealand WA Branch Technical Meeting, 13th October 2010. Perth: Curtin University.
3. Ministry of Agriculture, Food & Rural Affairs (MAFRA). 2003. Factsheet: Effects of Air Pollution on Agricultural Crops. http://www.omafra.gov.on.ca/english/crops/facts/01-015.htm (accessed on 24th October 2008)
4. Department of the Environment and Water Resources (DEWR). 2007. Substance fact sheets. http://www.npi.gov.au/database/substance-info/profiles/index.html (accessed 21st January 2009).

GLOSSARY

Air Pollution

Degradation of air quality by the presence of natural and foreign substances present in the atmosphere, which can have adverse impacts on human health, vegetation, livestock, agriculture, materials and aesthetics (e.g. visibility).

Airshed

An airshed is a body of air surrounded by topography and meteorology in which a contaminant, once emitted, is contained. Generally all parts of the geographical area are subject to similar conditions of air pollution. For example the Perth airshed is defined as the area contained within the Perth metropolitan region.

Air toxics

Air toxics represent a large number of air pollutants that are present in the ambient air and have characteristics that are hazardous to human health and the environment. Air toxics include benzene, 1,3 butadiene, polycyclic aromatic hydrocarbons, heavy metals, volatile and semi-volatile organic compounds and persistent organic pollutants. Air toxics are produced by motor vehicles, industry emissions, paints and adhesives, cigarette smoke and burning of fuel including the incomplete combustion of wood. Exposure to air toxics can produce increased eye, nose and throat irritation. Air toxic exposure is also linked to increased occurrences of cancer, and respiratory and nervous system damage.

Benzene

Benzene is a clear to light yellow coloured liquid, with an aromatic odour. It evaporates in the air easily, and is a hazardous air pollutant. Benzene can be produced during industry manufacture (e.g. plastics, pesticides) and is also used as a solvent. Benzene is also found in motor vehicle fuels. Health impacts associated with benzene exposure include skin and eye irritations, headaches, vomiting. Benzene is also a carcinogenic and long term exposure can lead to the development of cancer such as leukemia.4

Carbon monoxide (CO)

Carbon monoxide is a colourless, odourless, highly toxic gas, which is readily taken up by the blood and interferes with oxygen absorption. It is one of the most common and widely distributed air pollutants. It is commonly produced by motor vehicles, industrial emissions, cigarettes and area sources (homes and services stations). Relatively small quantities of carbon monoxide can impair bodily functions with prolonged and acute exposure being fatal.

Oxides of nitrogen (NO_x)

Oxides of nitrogen are gases that can undergo chemical reactions to produce photochemical smog. Most common are *nitric oxide, NO*, (colourless, odourless gas) and *nitrogen dioxide, NO_2*, (orange-brown gas with a stinging smell). They

are produced by the combustion of fossil fuels, motor vehicles, gas appliances, photochemical processes in the atmosphere and industry. Low levels of NOx can irritate and damage the eyes, nose, throat and lungs.

Particulate matter (PM)

Particulate matter is a mix of solid and liquid particles suspended in the air. Particles are produced by wood heaters, fires and diesel vehicles. Particles less than 10 microns (one seventh the width of a human hair) can lodge in respiratory tracts and lungs and have been linked to asthma, respiratory disease, cardiovascular disease and premature death. Particles with a diameter of 2.5 micrometres or less are small enough to penetrate deep into our lungs, causing irritation and structural damage.

Photochemical smog (Ozone)

Photochemical smog may be invisible to the naked eye and is characterized by high concentrations of ground level ozone. Ozone is formed when oxides of nitrogen and reactive organic compounds react together for a few hours under the influence of sunlight and high temperatures. Motor vehicles and industry are a major source of photochemical smog. Health studies have shown that ozone can have a negative impact on community health, in particular on respiratory health.

Polycyclic aromatic hydrocarbons (PAHs)

PAHs are a group of more than 100 organic compounds. They are colourless, whitish to greenish solids that often attach to particulate matter. They are the usually produced by combustion processes including motor vehicles, wood heaters, industrial emissions, agricultural burning and also natural sources (volcanoes and fire). They can cause health effects ranging from eye, nose and throat irritation to organ damage and may even cause death.

Toluene

Toluene or methylbenzene is a clear liquid with a sweet odour. Health impacts from toluene exposure include headaches, sleepiness, memory loss, nausea and kidney damage. Sources of toluene include motor vehicles emissions and industry (e.g. chemical, rubber) and exposure to paints, varnish, petrol, nail polish and paint cleaners [4]

Volatile organic compounds (VOCs)

VOCs cover a wide range of gaseous organic compounds and include hydrocarbons, oxygenates and halocarbons. Carbonyls are a reactive subset of VOCs. They include the aldehydes such as formaldehyde and acetaldehyde and the ketones such as acetone and methylethylketone. VOCs are found in carpets, particle-board, cigarette smoke, paper products, pesticides, cleaning agents, glues, paints, solvents and some industry emissions. Their main environmental significance is their role in photochemical smog formation. They can also cause health effects ranging from eye, nose and throat irritation to liver and kidney damage.

Xylenes

Xylenes are a soluble liquid with a sweet odour, that are used as solvents. Xylenes cause irritation to the eyes and throat, and can cause stomach problems, loss of memory, poor concentration, nausea, vomiting, and high levels can lead to dizziness and death. Sources of xylenes include chemical and petrol manufacture, motor vehicles, paints, woodburning stoves and fires, cleaners, oils and pesticides [4]

Sulphur Dioxide (SO_2)

Sulphur dioxide is a colourless gas which has a pungent odour similar to that of a struck match. Sulphur dioxide is a by-product of the burning of sulphur-bearing fuels such as oil and coal. Major sources are fossil-fuelled-powered generation stations, oil refineries, pulp mills and smelters. People with respiratory conditions or chronic lung and heart diseases are the most sensitive to SO_2 and may experience problems. Even those without these conditions may find it irritation to the eyes and throat.

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