
Approved Methods

for the Sampling and Analysis
of Air Pollutants
in New South Wales

Department of **Environment and Conservation** NSW



About this publication

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Contents

1. Introduction

Purpose of methods
Relevant legislation
Exceptional circumstances

2. Sample collection and handling

Stationary source monitoring
Approved circumstances
Ambient air monitoring

3. Methods for sampling and analysis

Table 1: Methods for the sampling and analysis of air pollutants from stationary sources in NSW

Table 2: Methods for the sampling and analysis of air pollutants from mobile sources and motor vehicle fuels in NSW

Table 3: Methods for the sampling and analysis of ambient air pollutants in NSW

4. Analytical report

Stationary source monitoring
Ambient air monitoring

5. References

Appendices

Appendix I: Definitions and generic procedures that apply to stationary source monitoring and reporting

Appendix II: Test method 19 – Determination of total mass of unburnt organic vapours from vapour disposal units

Appendix III: Test method 20 – Determination of total mass of unrecovered organic vapours from vapour recovery units

Appendix IV: Test method 21 – Calculation of vapour pressure

Appendix V: Test method 26 – Exhaust and evaporative emissions from spark-ignition motor vehicles

Appendix VI: Test method 27 – Lead concentration in leaded and unleaded petrol

Appendix VII: Test method 31 – Observation procedure for excessive air impurities: visible emissions

Appendix VIII: Test method 38 – Combination of air impurities from 2 or more sources

Appendix IX: Other approved method 9 – ‘Coarse’ particulates

Appendix X: Test method sources

1. Introduction

Purpose of methods

This document lists the methods to be used for the sampling and analysis of air pollutants in New South Wales for statutory purposes. The document covers:

- pollutant emissions from stationary sources
- pollutant emissions from motor vehicles
- components in and properties of petroleum products
- pollutants in ambient air.

Relevant legislation

This document is referred to in:

- the Protection of the Environment Operations (Clean Air) Regulation 2002, Part 4 Emission of Air Impurities from Activities and Plant
- the Protection of the Environment Operations (Clean Air) Regulation 2002, Part 5 Motor Vehicles and Motor Vehicle Fuels
- the Protection of the Environment Operations (General) Regulation 1998.

It may also be referred to in conditions attached to statutory instruments, such as licences or notices, issued under environment protection legislation, as defined in the *Protection of the Environment Operations Act 1997*.

Industry has an obligation to ensure compliance with limits specified in the Protection of the Environment Operations (Clean Air) Regulation 2002, Part 4 Emission of Air Impurities from Activities and Plant and Part 5 Motor Vehicles and Motor Vehicle Fuels, and certain statutory instruments. All monitoring to show compliance must be done in one of three ways:

- in accordance with the methods specified in this document
- in accordance with the methods specified in the relevant statutory instrument
- if no method is specified in either this document or the statutory instrument, in a manner approved by the EPA in writing before any tests are conducted.

Exceptional circumstances

In exceptional circumstances, the EPA may approve the use of alternative methods to those provided here. An application for approval of a test method (TM), continuous emissions monitoring method (CEM), other approved method (OM) or ambient monitoring method (AM) as an equivalent alternative to a method in this document (the 'approved method') must be made in writing to the Chief Scientist, Environment Protection Authority.

The application must:

- demonstrate that there are exceptional circumstances that justify the use of a method other than the approved method
- give comprehensive technical details of the alternative method for which approval is sought
- show that the alternative method is scientifically sound

- show that the alternative method would produce results comparable to those produced by the approved method. This involves establishing method equivalency, by following the procedure outlined in USEPA Method 301, including the optional sections where appropriate.

The EPA will not approve an alternative to a specified TM, CEM, OM or AM unless it is satisfied that the application for approval gives adequate details of the proposed alternative method as listed above.

Any other method, which has been approved by the EPA in accordance with the approval procedures set out above as an equivalent alternative to a TM, CEM, OM or AM of a particular number in this document, is prescribed as an approved method of that same number.

2. Sample collection and handling

Stationary source monitoring

Collect, handle and preserve samples according to the relevant test method. Collect them at the locations determined in accordance with the relevant regulation or specified in the statutory instrument, as the case may be. If the regulation does not provide for determination of the locations or if no locations are specified in the instrument, collect them from locations where they are representative of the total or known portion of the source emissions.

Whenever a United States Environmental Protection Agency (USEPA) test method refers to USEPA (2000) Method 1, Standards Association of Australia, AS 4323.1-1995 must be substituted, except under approved circumstances. Whenever a USEPA test method refers to USEPA (2000) Method 5, AS 4323.2-1995 must be substituted, except under approved circumstances. Approved circumstances are defined in the following section.

Approved circumstances

The following table defines the approved circumstances for the use of AS 4323.1-1995, USEPA (2000) Method 1, AS 4323.2-1995 and USEPA (2000) Method 5.

Group	TM-1		TM-15	
	AS 4323.1-1995	USEPA (2000) Method 1	AS 4323.2-1995	USEPA (2000) Method 5
1, 2, 3, 4 and A	Under all circumstances	Under all circumstances	Under all circumstances	Under all circumstances
5 and B	Under all circumstances	Under exceptional circumstances	Under all circumstances	Under exceptional circumstances
6 and C	Under all circumstances	Under no circumstances	Under all circumstances	Under no circumstances

Note: Group, in relation to any activity or plant, means the Group to which the activity or plant belongs pursuant to its classification prescribed in the Protection of the Environment Operations (Clean Air) Regulation 2002, Part 4 Emission of Air Impurities from Activities and Plant, Division 2 and Division 3.

Ambient air monitoring

When siting ambient air monitoring equipment, follow AS 2922-1987. Monitoring sites are classified into three types: peak, neighbourhood or background. When selecting a monitoring site, you need to consider many parameters, including, locality, terrain, meteorology, emission sources, possible chemical or physical interference, availability of services and site security. Try to co-locate meteorological monitoring equipment and ambient air monitoring equipment unless site-representative meteorological data are available from another nearby meteorological monitoring site.

3. Methods for sampling and analysis

Analyses should be carried out by a laboratory accredited to perform them by an independent accreditation body acceptable to the EPA, such as the National Association of Testing Authorities (NATA).

Methods approved by the EPA for specific analytes and parameters are listed in Tables 1 to 3. In most cases, standard methods are referenced, with additional guidance or clarification given if needed. Where there is no suitable published method, a complete description of the approved method is given. Refer to Appendix X: Test method sources for the organisations that publish the approved methods.

Refer to Appendix I: Definitions and generic procedures that apply to stationary source monitoring and reporting.

Table 1: Methods for the sampling and analysis of air pollutants from stationary sources in NSW

A. Test methods (TM) prescribed for the purposes of the Protection of the Environment Operations (Clean Air) Regulation 2002, Part 4 Emission of Air Impurities from Activities and Plant

Method no.	Parameter measured	Method
TM-1	Selection of sampling positions	AS 4323.1-1995 or USEPA (2000) Method 1 under approved circumstances
TM-2	Velocity or volumetric flow rate or temperature or pressure of stack gases	USEPA (2000) Method 2 or 2C or USEPA (1999) Method 2F or 2G or 2H (as appropriate)
TM-3	Sulfuric acid mist (H ₂ SO ₄) or sulfur trioxide (SO ₃)	USEPA (2000) Method 8 (for sampling and analysis) or APHA (1998) Method 4110B (for analysis only if interference from fluorides, free ammonia and/or dimethyl aniline has been demonstrated to the satisfaction of the Chief Scientist) (as appropriate)
TM-4	Sulfur dioxide (SO ₂)	USEPA (2000) Method 6 or 6A or 6B or USEPA (1996) Method 6C or ISO (1989) Method 7934 or ISO (1992) Method 7935 or ISO (1993) Method 10396 or ISO (1998) Method 11632 (as appropriate)
TM-5	Hydrogen sulfide (H ₂ S)	USEPA (2000) Method 11 or USEPA (2000) Method 15 or USEPA (2000) Method 16 or Environment Canada (1992) Reference Method EPS1/RM/6 (as appropriate)
TM-6	Sulfur (S) in petroleum products	ASTM (2002) D4294-02 or ASTM (1998) D2622-98 or ASTM (2000) D129-00 (as appropriate)
TM-7	Chlorine (Cl ₂)	USEPA (2000) 26A
TM-8	Hydrogen chloride (HCl)	USEPA (2000) 26A
TM-9	Fluorine (F ₂) or any compound containing fluorine, except where emitted by a primary aluminium	USEPA (2000) Method 13A or 13B (as appropriate)

Method no.	Parameter measured	Method
	smelter while manufacturing aluminium from alumina	
TM-10	Hydrogen fluoride (HF) emitted by a primary aluminium smelter while manufacturing aluminium from alumina	USEPA (2000) Method 14 or USEPA (1997) Method 14A (as appropriate)
TM-11	Nitrogen dioxide (NO ₂) or nitric oxide (NO)	USEPA (2000) Method 7 or 7A or 7B or 7C or 7D or USEPA (1990) Method 7E or USEPA (1996) Method 20 or ISO (1993) Method 10396 (as appropriate). NO _x analysers may be substituted in Method 7E provided the performance specifications of the method are met. Both NO and NO _x must be directly measured.
TM-12	Type 1 substances (elements antimony (Sb), arsenic (As), cadmium (Cd), lead (Pb) or mercury (Hg) or any compound containing one or more of those elements)	USEPA (2000) Method 29 or USEPA (2000) Method 102 (for mercury only in hydrogen rich streams) (as appropriate)
TM-13	Type 2 substances (elements beryllium (Be), chromium (Cr), cobalt (Co), manganese (Mn), nickel (Ni), selenium (Se), tin (Sn) or vanadium (V) or any compound containing one or more of those elements)	USEPA (2000) Method 29 (Analysis for tin and vanadium to be done by Inductively Coupled Argon Plasma Emission Spectroscopy (ICAP) as defined in USEPA Method 29) or USEPA (1986) Method 7910 (for vanadium only) or USEPA (1986) Method 7911 (for vanadium only) (as appropriate)
TM-14	Cadmium (Cd) or mercury (Hg) or any compound containing one or more of those elements	USEPA (2000) Method 29 or USEPA (2000) Method 102 (for mercury only in hydrogen rich streams) (as appropriate)
TM-15	Solid particles (Total)	AS 4323.2-1995 or USEPA (2000) Method 5 under approved circumstances
TM-16	Smoke (if determining whether a specified Ringelmann standard has been exceeded)	AS 3543-1989
TM-18	Dioxins or furans	USEPA (1995) Method 23 (Duration of sampling must be between 6 and 16 hours. Several discrete samples may be taken such that the total sampling time is within the specified range but sampling time for each point must comply with TM-15)
TM-19	Volatile organic liquids: total mass of unburnt organic vapours, displaced by the transfer of volatile organic liquids from vapour disposal units	Appendix II: Test method 19
TM-20	Volatile organic liquids: total mass of unrecovered organic vapours, displaced by the transfer of volatile organic liquids from vapour recovery units	Appendix III: Test method 20

Method no.	Parameter measured	Method
TM-21	Volatile organic liquids: calculation of vapour pressure	Appendix IV: Test method 21
TM-22	Moisture content in stack gases	USEPA (2000) Method 4
TM-23	Dry gas density or molecular weight of stack gases	USEPA (2000) Method 3
TM-24	Carbon dioxide (CO ₂) in stack gases	USEPA (1990) Method 3A
TM-25	Oxygen (O ₂) in stack gases	USEPA (1990) Method 3A
TM-32 (formerly OM-1)	Carbon monoxide (CO)	USEPA (1996) Method 10
TM-33	Total reduced sulfides (TRS)	USEPA (2000) Method 16A or 16B (as appropriate)
TM-34 (formerly OM-2)	Volatile organic compounds	USEPA (2000) Method 18 or USEPA (2000) Method 25 or 25A or 25B or 25C or 25D or 25E (as appropriate)
TM-35	Methanol	USEPA (1997) Method 308
TM-37	Smoke (if determining whether standard for emission of smoke from flares has been exceeded)	USEPA (2000) Method 22
TM-38	Combination of air impurities from two or more sources	Appendix VIII: Test method 38

B. Continuous emission monitoring methods (CEM) prescribed for the purposes of the Protection of the Environment Operations (Clean Air) Regulation 2002, Part 4 Emission of Air Impurities from Activities and Plant

Method no.	Parameter measured	Method
CEM-1	Smoke (if determining whether a specified standard of concentration of opacity has been exceeded)	USEPA (2000) Performance Specification 1
CEM-2	Sulfur dioxide (SO ₂) or nitrogen dioxide (NO ₂) or nitric oxide (NO)	USEPA (2000) Performance Specification 2
CEM-3	Oxygen (O ₂) or carbon dioxide (CO ₂) in stack gases	USEPA (2000) Performance Specification 3
CEM-4	Carbon monoxide (CO)	USEPA (2000) Performance Specification 4
CEM-5	Total reduced sulfides (TRS)	USEPA (2000) Performance Specification 5
CEM-6	Velocity or volumetric flow rate of stack gases	USEPA (2000) Performance Specification 6
CEM-7	Hydrogen sulfide (H ₂ S)	USEPA (2000) Performance Specification 7
CEM-8	Volatile organic compounds or methanol	USEPA (2000) Performance Specification 8

Method no.	Parameter measured	Method
CEM-9	Volatile organic compounds or methanol	USEPA (2000) Performance Specification 9
CEM-10	Volatile organic compounds or methanol	USEPA (2000) Performance Specification 15

C. Other approved methods (OM)

Method no.	Parameter measured	Method
OM-3	Total or hexavalent chromium emissions from decorative and hard chromium electroplating and anodising operations	USEPA (2000) Method 306
OM-4	Total and hexavalent chromium emissions	California EPA Air Resources Board (1997) Method 425 or USEPA (1996) Method 0061 (as appropriate). (Method 0061 is validated for determination of hexavalent chromium from hazardous waste incinerators, municipal waste incinerators, municipal waste combustors and sewage sludge incinerators)
OM-5	'Fine' particulates (PM ₁₀)	USEPA (1997) Method 201 or 201A (as appropriate)
OM-6	Polycyclic aromatic hydrocarbons (PAHs)	California EPA Air Resources Board (1997) Method 429
OM-7	Odour sampling from point sources or odour analysis using dynamic olfactometry	AS 4323.3-2001
OM-8	Odour sampling from diffuse sources	USEPA (1986) EPA/600/8-8E/008
OM-9	'Coarse' particulates	Appendix IX: Other approved method 9

Note: Any other method, which has been approved by the EPA in accordance with the exceptional circumstances set out in this document as an equivalent alternative to a test method of a particular number in this document, is prescribed as a test method of that same number.

Table 2: Methods for the sampling and analysis of air pollutants from mobile sources and motor vehicle fuels in NSW

A. Test methods (TM) prescribed for the purposes of the Protection of the Environment Operations (Clean Air) Regulation 2002, Part 5 Motor Vehicles and Motor Vehicle Fuels

Method no.	Parameter measured	Method
TM-26	Exhaust and evaporative emissions from spark-ignition motor vehicles	Federal Office of Road Safety ADR 37/00 (1989) or ADR 37/01 (1995) (as appropriate). Refer to Appendix V: Test method 26 for additional guidance
TM-27	Lead concentration in leaded and	Appendix VI: Test method 27

Method no.	Parameter measured	Method
	unleaded petrol	
TM-28	Phosphorus concentration in unleaded petrol	ASTM (1994) D3231-94
TM-29	Research octane number of unleaded petrol	ASTM (1997) D2699-97
TM-30	Motor octane number of unleaded petrol	ASTM (1997) D2700-97
TM-31	Observation procedure for excessive air impurities: visible emissions	Appendix VII: Test method 31

Note: Any other method, which has been approved by the EPA in accordance with the exceptional circumstances set out in this document as an equivalent alternative to a test method of a particular number in this document, is prescribed as a test method of that same number.

Table 3: Methods for the sampling and analysis of ambient air pollutants in NSW

A. General methods for ambient air monitoring (AM)

Method no.	Parameter measured	Method
AM-1	Guide for the siting of sampling units	AS 2922-1987
AM-2	Guide for measurement of horizontal wind for air quality applications	AS 2923-1987
AM-3	Preparation of reference test atmospheres	AS 3580.2.1-1990 or AS 3580.2.2-1990 (as appropriate)
AM-4	Meteorological monitoring guidance for regulatory modelling applications	USEPA (2000) EPA 454/R-99-005

B. Specific methods for ambient air monitoring (AM)

Method no.	Parameter measured	Method
AM-5	Acid gases	AS 3580.3.1-1990
AM-6	Carbon monoxide	AS 3580.7.1-1992
AM-7	Fluorides – automated, double paper tape sampling method	AS 3580.13.1-1993
AM-8	Fluorides – manual, double filter paper sampling method	AS 3580.13.2-1991
AM-9	Fluorides –sodium acetate coated tube absorption method	AS 3580.13.3-1993
AM-10	Hydrogen sulfide	AS 3580.8.1-1990
AM-11	Lead – particulate collection by high-volume sampler	AS 2800-1985

Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales

Method no.	Parameter measured	Method
AM-12	Nitrogen oxides	AS 3580.5.1-1993
AM-13	Ozone	AS 3580.6.1-1990
AM-14	Particulate matter – suspended matter – filter paper soiling method	AS 2724.2-1987
AM-15	Particulate matter – TSP – high-volume sampler method	AS 2724.3-1984
AM-16	Particulate matter – light scattering – integrating nephelometer method	AS 2724.4-1987
AM-17	Particulate matter – impinged matter – directional dust gauge method	AS 2724.5-1987
AM-18	Particulate matter – PM ₁₀ – high-volume sampler with size-selective inlet	AS 3580.9.6-1990
AM-19	Particulates – deposited matter – gravimetric method	AS 3580.10.1-1991
AM-20	Sulfur dioxide	AS 3580.4.1-1990
AM-21	Volatile organic compounds	AS 3580.11.1-1993
AM-22	Particulate matter – PM ₁₀ – TEOM	AS 3580.9.8-2001

Note: Any other method, which has been approved by the EPA in accordance with the exceptional circumstances set out in this document as an equivalent alternative to a test method of a particular number in this document, is prescribed as a test method of that same number

4. Analytical report

Stationary source monitoring

The results of any monitoring required by a statutory instrument must be provided as a summary report signed by the licence holder or, where there is no licence, by the person required to provide the report. The report must contain at least the following information for each air contaminant, unless the statutory instrument states otherwise:

- name and address of reporting organisation or individual
- date of issue of the report
- date, time and place of measurements
- identification of source tested
- the test method used and details of any deviation from that method
- details of source or process operating conditions during sampling and a statement about the representativeness of the sample taken
- location of sampling plane, with respect to the nearest upstream and downstream flow disturbances
- number of sampling points
- period of sampling (start and end times)
- average stack gas velocity in metres per second
- average stack gas temperature in kelvins
- contaminant molecular weight or density in kilograms per cubic metre
- water content of stack gas, expressed as a percentage by volume
- stack gas volumetric flow rate on a dry basis under standard conditions, in cubic metres per second
- concentration of contaminant on a dry basis under standard conditions, in grams per cubic metre
- mass emission rate of contaminant on a dry basis under standard conditions, in grams per second
- details of sample preservation, if applicable
- any factors that may have affected the monitoring results
- the precision of the results (using AS 2706 as a guide)
- details of the most recent calibration of each instrument used to take measurements.

If an air contaminant cannot be detected, results must not be quoted as zero but as less than the method's limit of detection.

All volumes and concentrations are normally reported as dry at a temperature of 0°C and at an absolute pressure of 101.3 kilopascals (kPa). The EPA's monitoring requirements may also specify a reference gas level to which the result must be corrected.

Ambient air monitoring

The results of any monitoring required by a statutory instrument must be provided as a summary report signed by the licence holder or, where there is no licence, by the person required to provide the report. The report must contain at least the following information for each air contaminant, unless the statutory instrument states otherwise:

- name and address of reporting organisation or individual
- date of issue of the report
- the test method used and details of any deviation from that method
- period of monitoring (start and end dates and percentage of time the instruments were on-line)
- location of monitoring points (normal address and Australian Map Grid reference, height above nominal ground level, and a description of the terrain features)
- the air pollutants measured, the monitoring instruments used, and a description of the air sampling system
- maximum hourly average concentration, daily average concentration, and appropriate longer-term averages
- appropriate statistical information to describe the variability and range of the concentrations
- any factors that may have affected the monitoring results
- the precision of the results (using AS 2706 as a guide)
- details of the most recent calibration of each instrument used to take measurements.

5. References

American Public Health Association

APHA 1998, **Method 4110B** – Determination of anions by ion chromatography: Ion chromatography with chemical suppression of eluent conductivity, Standard Methods for the Examination of Water and Wastewater, 20th Edition.

American Society for Testing and Materials

ASTM 1994, **D3231-94**: Standard test method for phosphorus in gasoline, American Society for Testing and Materials, West Conshohocken, PA.

ASTM 2000, **D129-00**: Standard test method for sulfur in petroleum products (general bomb method), American Society for Testing and Materials, West Conshohocken, PA.

ASTM 1997, **D2699-97**: Standard test method for research octane number of spark-ignition engine fuel, American Society for Testing and Materials, West Conshohocken, PA.

ASTM 1997, **D2700-97**: Standard test method for motor octane number of spark-ignition engine fuel, American Society for Testing and Materials, West Conshohocken, PA.

ASTM 1997, **D3237-97**: Standard test method for lead in gasoline by atomic absorption spectroscopy, American Society for Testing and Materials, West Conshohocken, PA.

ASTM 1998, **D2622-98**: Test method for sulfur in petroleum products (X-ray spectrographic method), American Society for Testing and Materials, West Conshohocken, PA.

ASTM 2002, **D4294-02**: Standard test method for sulfur in petroleum products by energy-dispersive X-ray fluorescence spectroscopy, American Society for Testing and Materials, West Conshohocken, PA.

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California Environmental Protection Agency Air Resources Board 1997, **Method 425**: Determination of total chromium emissions from stationary sources, Sacramento, CA.

California Environmental Protection Agency Air Resources Board 1997, **Method 429**: Polycyclic aromatic hydrocarbon (PAH) emissions from stationary sources, Sacramento, CA.

Environment Canada

Environment Canada 1992, **Reference Method EPS1/RM/6**: Reference method for source testing – Measurement of releases of Total Reduced Sulphur (TRS) compounds from pulp and paper operations.

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Federal Office of Road Safety 1995, **Australian Design Rule 37/01**: Emission control for light vehicles, Canberra.

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International Standard Organisation, **ISO (1989) Method 7934**: Stationary source emissions – Determination of mass concentration of sulphur dioxide – Hydrogen peroxide/barium perchlorate/thorin method.

International Standard Organisation, **ISO (1992) Method 7935**: Stationary source emissions – Determination of the mass concentration of sulphur dioxide – Performance characteristics of automated measuring methods.

International Standard Organisation, **ISO (1993) Method 10396**: Stationary source emissions – Sampling for the automated determination of gas concentrations.

International Standard Organisation, **ISO (1998) Method 11632**: Stationary source emissions – Determination of mass concentration of sulphur dioxide – Ion chromatography method.

Standards Association of Australia 1984–89

Standards Association of Australia 1984, **AS 2724.3–1984**: Particulate matter – determination of total suspended particulates (TSP) – high volume sampler gravimetric method, Homebush, NSW.

Standards Association of Australia 1985, **AS 2800–1985**: Particulate lead – high volume sampler gravimetric collection – flame atomic absorption spectrometric method, Homebush, NSW.

Standards Association of Australia 1987, **AS 2724.2–1987**: Particulate matter – determination of suspended matter expressed as equivalent black smoke by filter paper soiling, Homebush, NSW.

Standards Association of Australia 1987, **AS 2724.4–1987**: Particulate matter – determination of light scattering – integrating nephelometer method, Homebush, NSW.

Standards Association of Australia 1987, **AS 2724.5–1987**: Particulate matter – determination of impinged matter expressed as directional dirtiness, background dirtiness and/or area dirtiness (directional dust gauge method), Homebush, NSW.

Standards Association of Australia 1987, **AS 2922–1987**: Guide for the siting of sampling units, Homebush, NSW.

Standards Association of Australia 1987, **AS 2923–1987**: Guide for measurement of horizontal wind for air quality applications, Homebush, NSW.

Standards Association of Australia 1989, **AS 3543–1989**: Use of standard Ringelmann and Australian Standard miniature smoke charts, Homebush, NSW.

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Standards Association of Australia 1990, **AS 1876–1990**: Petrol (gasoline) for motor vehicles, Homebush, NSW.

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Standards Association of Australia 1990, **AS 3580.3.1–1990**: Acid gases – titrimetric method, Homebush, NSW.

Standards Association of Australia 1990, **AS 3580.4.1–1990**: Sulfur dioxide – direct reading instrumental method, Homebush, NSW.

Standards Association of Australia 1990, **AS 3580.6.1–1990**: Ozone – direct-reading instrumental method, Homebush, NSW.

Standards Association of Australia 1990, **AS 3580.8.1–1990**: Hydrogen sulfide – automatic intermittent sampling – gas chromatographic method, Homebush, NSW.

Standards Association of Australia 1990, **AS 3580.9.6–1990**: Suspended particulate matter – PM₁₀ high volume sampler with size-selective inlet – gravimetric method, Homebush, NSW.

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Standards Association of Australia 1991, **AS 3580.10.1–1991**: Particulates – deposited matter – gravimetric method, Homebush, NSW.

Standards Association of Australia 1991, **AS 3580.13.2–1991**: Fluorides – gaseous and acid-soluble particulate fluorides – manual, double filter paper sampling Homebush, NSW.

Standards Association of Australia 1992, **AS 3580.7.1–1992**: Carbon monoxide – direct-reading instrumental method, Homebush, NSW.

Standards Association of Australia 1993, **AS 3580.5.1–1993**: Oxides of nitrogen – chemiluminescence method, Homebush, NSW.

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USEPA Method 301

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USEPA Method 306

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USEPA Method 308

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Appendix I: Definitions and generic procedures that apply to stationary source monitoring and reporting

Cubic metre (m³)

In this document a cubic metre (m³) refers to the volume of dry gas that occupies 1 m³ at a temperature of 0°C (273 K) and at an absolute pressure equivalent to 1 atmosphere (101.3 kPa)

Measuring concentrations and volumes in gases

When reporting concentrations of pollutants in gases for comparison with emission standards or with limits in regulations, licences, approvals, statutory notices, guidelines, codes of practice or environmental management plans, you must use the following conversions. However, where any of these conversions are part of the test method used to determine the concentration, they do not need to be repeated for reporting.

The test method for a pollutant gives the volume of gas sampled at the test conditions (i.e. moisture, temperature, pressure, oxygen and carbon dioxide, etc.) at the sample point, V_a.

Adjustment to reference conditions

1. Dry basis

Calculate the volume of dry gas at sample point conditions (V_b):

$$V_b = V_a \times (100 - MC) \div 100$$

2. Standard temperature

Calculate the volume of dry gas at standard temperature (273 K) (V_c):

$$V_c = V_b \times 273 \div (273 + \text{gas meter temperature in } ^\circ\text{C})$$

3. Standard pressure

Calculate the volume of dry gas at standard pressure (101.3 kPa) (V_d):

$$V_d = V_c \times (\text{gas meter pressure in kPa}) \div 101.3$$

4. Determine concentration as dry basis, standard temperature and standard pressure

Divide the measured mass of pollutant (M_a) by V_d to determine the concentration (C_a):

$$C_a = M_a \div V_d$$

5. Oxygen

For adjustment to an oxygen reference, the adjusted concentration of a pollutant, C_b, is determined by:

$$C_b = C_a \times (21 - \text{reference oxygen concentration as volume } \%) \div (21 - \text{measured oxygen concentration as volume } \%)$$

where:

C_a = the measured concentration of the pollutant, reported at the standard reference conditions

6. Carbon dioxide

For adjustment to a carbon dioxide reference, the adjusted concentration of a pollutant, C_c , is determined by:

$$C_c = C_a \times 12 \div \text{measured carbon dioxide concentration as volume \%}$$

where:

C_a = the measured concentration of the pollutant, reported at the standard reference conditions

7. Nitrogen dioxide

Oxides of nitrogen (NO_x) from combustion of fossil fuels consist predominantly of nitric oxide (NO) and nitrogen dioxide (NO_2). Oxides of nitrogen concentrations are converted to equivalent NO_2 as follows:

$$\text{Equivalent NO}_2 = \text{calculated NO}_2 + (\text{measured NO} \times 46 \div 30)$$

where:

$$\text{calculated NO}_2 = \text{measured NO}_x - \text{measured NO}$$

$$46 = \text{molecular weight of NO}_2$$

$$30 = \text{molecular weight of NO}$$

Both NO and NO_x must be measured directly.

Conversion from volume- to mass-based units of concentration

Equation 1: Ideal gas law

The physical state of gaseous air pollutants at environmental concentrations may be described by the ideal gas law, as follows:

$$P \times V = n \times R \times T$$

where:

P = absolute pressure of gas (atm)

V = volume of gas (L)

N = number of moles of gas (mol)

R = universal gas constant (L.atm/mol.K)

T = absolute temperature (K)

Equation 2

The number of moles (n) may be calculated from the mass of a pollutant (m) and its molecular weight (MW) as follows:

$$n = m/MW$$

Equation 3

Substituting Equation 2 into Equation 1 and rearranging terms yields:

$$V = m \times R \times T/P \times MW$$

Equation 4

Parts per million (ppm) refers to the volume of pollutant (V) per million volumes of air (A):

$$\text{ppm} = V/A \times 10^6$$

Equation 5: Conversion from volume-to mass-based units of concentration

Substituting Equation 3 into Equation 4 yields:

$$ppm = \frac{m}{A} \frac{R \times T}{P \times MW \times 10^6}$$

Using the appropriate values for the variables in Equation 5, a conversion from volume to mass based units of concentration for carbon monoxide may be derived as shown below:

$$T = 298.15 \text{ K (25 } ^\circ\text{C)}$$

$$P = 1 \text{ atm}$$

$$MW = 28 \text{ g/mol}$$

$$R = 0.08205 \text{ L.atm/mol.K}$$

$$ppm = \frac{m(g) \times 10^3 (mg/g)}{A(l)} \times \frac{0.08205 (L.atm/mol.K) \times 298.15 (K)}{1(atm) \times 28(g/mol) \times 10^6}$$

$$1 \text{ ppm} = 1.15 \text{ mg/m}^3$$

$$1 \text{ mg/m}^3 = 0.873 \text{ ppm}$$

Conversions at 273 K and 1 atmosphere

$$C \text{ (mg/m}^3\text{)} = C \text{ (ppm)} \times (MW/22.4)$$

$$C \text{ (ppm)} = C \text{ (mg/m}^3\text{)} \times (22.4/MW)$$

where:

C = concentration

MW = molecular weight

22.4 = the volume of one litre of air at 1 atmosphere and 273 K

Volatile organic compounds

Calculation of VOC as n-propane equivalent on a mass basis

VOC as n-propane equivalent is the sum of the concentrations of each individual VOC species which are measured by a GC, or a similar method, and corrected to VOC as n-propane equivalent.

If speciated gaseous non-methane organics (SGNMO) have been measured using TM-34 (USEPA (2000) Method 18), use the following procedure to convert the concentration of each individual VOC species to VOC as n-propane equivalent:

$$C_{VOC} = \sum_{i=1}^N (C_i \div MW_i \times 44)$$

where:

C_{VOC} = the calculated concentration of VOC as n-propane equivalent in mg/m^3 (dry, 273 K, 101.3 kPa)

C_i = the measured concentration of each individual VOC species in mg/m^3 (dry, 273 K, 101.3 kPa)

MW_i = the molecular weight of each individual VOC species in g/mol

44 = the molecular weight of n-propane in g/mol

Calculation of TOC equivalent on a mass basis

Total organic carbon (TOC) equivalent is the sum of the concentrations of each individual VOC species which are measured by a GC, or a similar method, and corrected to TOC equivalent.

If speciated gaseous non-methane organics (SGNMO) have been measured using TM-34 (USEPA (2000) Method 18), use the following procedure to convert the concentration of each individual VOC species to TOC equivalent:

$$C_{TOC} = \sum_{i=1}^N ((C_i \div MW_i) \times (K_i \times 12))$$

where:

C_{TOC} = the calculated concentration of TOC in mg/m³ (dry, 273 K, 101.3 kPa)

C_i = the measured concentration of each individual VOC species in mg/m³ (dry, 273 K, 101.3 kPa)

MW_i = the molecular weight of each individual VOC species in g/mol

K_i = the carbon correction factor (number of carbons in the molecule) for each species

Conversion of total VOC as n-propane equivalent to TOC equivalent on a volume basis

TOC equivalent is a measure of the amount of gaseous or vapour phase organic carbon which is measured by a FID, or similar method, and expressed as TOC equivalent.

If total gaseous non-methane organics (TGNMO) have been measured using TM-34 (USEPA (2000) Method 25 or 25A or 25B or 25C or 25D or 25E), use the following procedure to convert VOC as n-propane equivalent (or other calibrating gas) to total organic carbon (TOC) equivalent and vice versa:

$$C_{TOC} = K \times C_{VOC}$$

where:

C_{TOC} = the calculated concentration of TOC as carbon equivalent in ppmv

C_{VOC} = the measured concentration of VOC as n-propane equivalent (or other calibrating gas) in ppmv

K = the carbon equivalent correction factor (This is the number of carbons in the molecule and has a value of 3 if n-propane is used as the calibrating gas. An appropriate carbon equivalent correction factor should be selected if a calibrating gas other than n-propane is used.)

Conversion of TOC equivalent on a volume basis to TOC equivalent on a mass basis

$$C_{TOC} \text{ (mg/m}^3\text{)} = C_{TOC} \text{ (ppm)} \times (12/22.4)$$

where:

C_{TOC} = the concentration of TOC as total organic carbon equivalent

12 = the molecular weight of carbon

22.4 = the volume of one litre of air at 1 atmosphere and 273 K

Appendix II: Test method 19 – Determination of total mass of unburnt organic vapours from vapour disposal units

Sampling

Draw the exhaust gases through a 316 stainless steel probe to a sample line of PTFE or 316 stainless steel held at a temperature of at least 105°C.

Pass the exhaust gases to a device capable of reducing the moisture content of the gases to a dew point of less than 3°C. Filter the sample gases to remove entrained particles.

Analysis

Pass the conditioned sample gases to the following two analysers.

Hydrocarbon analyser (flame ionisation detector type)

Set the analyser to zero with air that has a hydrocarbon concentration of less than 10 ppm by volume of propane. Calibrate it with a gas of known propane concentration to give a deflection of between 20% and 90% of full scale on the range being used.

The average of the indicated concentration of hydrocarbons in the conditioned sample gases must lie between 30% and 90% of full-scale deflection of the analyser. The combined effects of carbon dioxide and carbon monoxide in the gases must not affect the reading by more than 2% of full-scale deflection. The deviation from linear response of the analyser must not exceed 2.5% of full-scale deflection.

Carbon dioxide analyser (non-dispersive infrared type)

Set the analyser to zero with nitrogen that has a carbon dioxide concentration of less than 0.05% by volume. Calibrate it with a gas of known carbon dioxide concentration to give a deflection of between 20% and 90% of full scale on the range being used.

The analyser must have a full-scale range for carbon dioxide concentration lying between 0% and 14% and 0% and 20% by volume. The deviation from linear response of the analyser must not exceed 2.5% of full-scale deflection.

Calculation of mass of unburnt organic vapours

The mass of unburnt organic vapours in each cubic metre of the exhaust gases is equal to:

$$C \div (42.3 \times L) \text{ grams}$$

where:

C = the average concentration of hydrocarbons measured as equivalent propane in ppm over the test period

42.3 = a conversion factor

L = the average concentration of carbon dioxide content expressed as a percentage of sample gases

Appendix III: Test method 20 – Determination of total mass of unrecovered organic vapours from vapour recovery units

Sampling

Draw the exhaust gases through a sample line of PTFE or 316 stainless steel construction. Pass them to a hydrocarbon analyser (flame ionisation detector type).

Analysis

Set the analyser to zero with air that has a hydrocarbon concentration of less than 10 ppm by volume of propane. Calibrate the analyser with a gas of known propane concentration to give a deflection of between 20% and 90% of full scale on the range being used.

The average of the indicated concentration of hydrocarbons in the exhaust gases must lie between 30% and 90% of full-scale deflection of the analyser. The combined effects of carbon dioxide and carbon monoxide in the gases must not affect the reading by more than 2% of full-scale deflection. The deviation from linear response of the analyser shall not exceed 2.5% of full-scale deflection.

Calculation of mass of unrecovered organic vapours

The mass of unrecovered organic vapours emitted for each litre of organic liquid is:

$$(318 \times C \times A \times M \times P \times V) \div (L \times T) \text{ milligrams}$$

where:

C = the average concentration of hydrocarbons expressed as equivalent propane in ppm over the test period

A = the cross-sectional area of the exhaust duct at the plane where the measurements are made in m²

M = the total time for organic liquid to pass into the tank or out of the industrial plant in minutes

P = the atmospheric pressure in kPa

V = the average exhaust gas velocity in metres per second

L = the volume of organic liquid passing into the tank or out of the industrial plant in litres

T = the average exhaust gas temperature in kelvins (273 + temperature in °C)

318 = a conversion factor

**Appendix IV:
Test method 21 – Calculation of vapour pressure**

A volatile organic liquid for which the Reid vapour pressure may be ascertained shall be deemed to have a vapour pressure exceeding 75 kilopascals if the maximum bulk storage temperature of the liquid is greater than the temperature specified in Column 2 of the table below corresponding to the Reid vapour pressure of the liquid specified in Column 1.

Where the Reid vapour pressure of the liquid lies between two adjacent values specified in Column 1 of the table, the corresponding temperature may be calculated as though a linear relationship existed between the Reid vapour pressure and the temperature at and between those two values.

Where the Reid vapour pressure of the liquid lies outside the values specified in Column 1 of the table or cannot be determined, the vapour pressure of the liquid shall be calculated by such methods as the EPA may determine.

Column 1 Reid vapour pressure (kPa)	Column 2 Temperature (°C)
50	49
60	43
70	38
80	33
90	29
100	26

Appendix V:

Test method 26 – Exhaust and evaporative emissions from spark-ignition motor vehicles

Testing must be carried out in accordance with the test procedures appropriate for the category of vehicle being tested and its date of manufacture specified in ADR 37/00 or ADR 37/01, *Emission Control for Light Vehicles*. Special conditions apply, as detailed below.

A reference here to components applies only to those components related to the emission performance of the motor vehicle being tested.

1. Compliance testing of new petrol-powered light vehicles

- Test the vehicle in the condition in which it is presented for testing (no tuning or special stabilisation distance run-in) unless the manufacturer or its agent requests special preparations to be made before testing.
- In evaporative emissions testing of a vehicle less than 56 days after it was manufactured, the Clean Air (Motor Vehicles and Motor Vehicle Fuels) Regulation 1997 allows for 1 to 3 g of hydrocarbon emissions emanating from sources other than the fuel system of the vehicle.

2. Compliance testing of in-service petrol-powered light vehicles up to five years old or with 80,000 km accumulated

- The engine of the vehicle must be tuned to the manufacturer's specifications.
- Where components originally fitted to the vehicle have been removed, disabled or tampered with, they must be replaced or repaired before testing.
- Components that are faulty or broken through normal use of the vehicle must not be replaced or repaired before testing.
- Components whose performance has deteriorated through normal use must not be replaced before testing.

3. Compliance testing of in-service dual-fuel (petrol/LPG) light vehicles up to five years old or with 80,000 km accumulated, operating on liquefied petroleum gas (LPG)

- All conditions in 2 (above) apply.
- Do not conduct the evaporative emission testing procedure.
- Do not apply any heat source to the vehicle's LPG storage container(s) during testing.
- Use LPG consisting of 50% butane and 50% propane. If this is not available, use commercially available LPG.

4. Compliance testing of in-service dual-fuel (petrol/LPG) light vehicles up to five years old or with 80,000 km accumulated, operating on petrol

- All conditions in 2 (above) apply.
- Do not apply any heat source to the vehicle's LPG storage container(s) during testing.

5. Compliance testing of in-service dual-fuel (petrol/CNG) light vehicles up to five years old or with 80,000 km accumulated, operating on compressed natural gas (CNG)

- All conditions in 2 (above) apply.
- Do not conduct the evaporative emission testing procedure.
- Do not apply any heat source to the vehicle's CNG storage container(s) during testing.
- Use commercially available CNG for this test.

6. Compliance testing of in-service dual-fuel (petrol/CNG) light vehicles up to five years old or with 80,000 km accumulated, operating on petrol

- All conditions in 2 (above) apply.
- Do not apply any heat source to the vehicle's CNG storage container(s) during testing.

Appendix VI: Test method 27 – Lead concentration in leaded and unleaded petrol

The lead in all petrol must be determined with this test method. The method was developed by the EPA from the standard test methods AS 1876-1990 *Petrol (Gasoline) for Motor Vehicles* and ASTM D3237-97 *Standard Test Method for Lead in Gasoline by Atomic Absorption Spectrometry*.

Applicability

This method is independent of the lead alkyl type and should be used to sample from bowsers, tanks, delivery tanks, tank vehicles, motor vehicles and pipelines.

Principle

The petrol sample is diluted with methyl isobutyl ketone, and the alkyl lead compounds are stabilised by reaction with iodine and a quaternary ammonium salt. The lead content of the sample is determined by atomic absorption flame spectrophotometry at 283 nm. Standards prepared from reagent-grade lead chloride are used for calibration.

Range

Lead concentrations in the range 0.005 to 1 g/L can be determined. Higher lead concentrations require dilution with iso-octane before analysis.

Sampling and storage

Containers for samples

Sampling containers must be metal cans with welded side seams and a minimum capacity of 250 mL. Each container must have an opening at the top of 30 to 50 mm in diameter. The top must be sealed with a vapour-tight screw cap.

Number of samples

Take two samples of the petrol to be tested and analyse the lead content of each. If requested, leave a third sealed sample with the owner or the person in charge.

Sampling from a bowser

Pour the petrol directly from the nozzle of the bowser hose into the top opening of the sample container. Fill the container to near capacity.

Sampling from other sources

Take a representative sample. Pour it into a sample container for transport.

Storage

Store samples at 0° to 8°C. Bring them to room temperature before analysis.

Cleaning procedures

Rinse the sampling containers with acetone (propanone) or iso-octane. Dry them in a drying cabinet at 40°C or higher.

Reagents

- MIBK: methyl isobutyl ketone (4-methyl-2-pentanone) (AR grade).
- Iodine solution: Dissolve 3.0 g AR grade iodine in AR grade toluene and dilute to 100 mL with the toluene. Store in a brown glass bottle.
- Aliquat 336: Tricapryl methyl ammonium chloride.
- 10% Aliquat 336/MIBK solution: Dilute 100 mL of Aliquat 336 to 1 L with MIBK.
- 1% Aliquat 336/MIBK Solution: Dilute 10 mL of Aliquat 336 to 1 L with MIBK.
- Lead chloride: At least 99% pure.
- Stock lead solution (2000 mg/L): Dry lead chloride at $105^{\circ} \pm 5^{\circ}\text{C}$ for 3 hours. Dissolve 0.6711 g in about 200 mL of 10% Aliquat 336/MIBK solution. Dilute to the mark in 250 mL volumetric flask with 10% Aliquat 336/MIBK solution. Mix well and store in a brown glass bottle.
- Intermediate stock lead solution (100 mg/L): Transfer accurately by pipette 5 mL of stock lead solution to a 100 mL volumetric flask. Dilute to the mark with 10% Aliquat 336/MIBK solution. Mix well and store in a brown glass bottle.
- Iso-octane: 2,2,4-trimethylpentane (AR grade).
- Nitric acid (1+1): Mix equal volumes of concentrated AR grade nitric acid and distilled water.
- Acetone (AR grade).

Maximum storage periods for reagents:

- Iodine solution – 30 days
- 10% Aliquat 336/MIBK – 30 days
- 1% Aliquat 336/MIBK – 30 days
- Stock lead solution – 30 days
- Standard lead solution – 1 day

Grades of reagents other than those indicated may be used with two provisos:

- The reagent is of high enough purity to permit its use without lessening the accuracy of the determination.
- The same source of reagent is used for all standards and blanks.

Analysis

General

Glassware must be de-lead by rinsing with dilute nitric acid (1+1) and then rinsed with distilled water. Wash the glassware with acetone and dry it at $50^{\circ} \pm 5^{\circ}\text{C}$.

Preparation of working standards (2, 5, 10, 20 mg/L)

Transfer accurately by pipette 1.0, 2.5, 5.0 and 10.0 mL of the intermediate stock lead solution (100 mg/L) to four 50 mL volumetric flasks. Adjust the volume of each to 10 mL by adding 1% Aliquat/MIBK solution and add 10 mL of iso-octane. Add 0.1 mL of iodine solution, mix well and allow to react for at least 1 minute. Dilute to volume with MIBK and mix.

Preparation of the blank

To a 50 mL volumetric flask add 30 mL of MIBK then 10 mL of iso-octane. Add 0.1 mL of iodine solution, mix well and allow to react for at least 1 minute. Add 5 mL of 1% Aliquat/MIBK solution and mix. Dilute to volume with MIBK and mix.

Preparation of sample

- For petrol with a lead concentration of < 0.1 g/L: To a 50 mL volumetric flask containing 30 mL of MIBK and 10 mL of petrol sample, add 0.1 mL of iodine solution. Mix well and allow to react for at least 1 minute. Add 5 mL of 1% Aliquat/MIBK solution. Dilute to volume with MIBK and mix.
- For petrol with a lead concentration of 0.1–1 g/L: To a 50 mL volumetric flask add 30 mL of MIBK. Add 1–5 mL of petrol sample and enough iso-octane to yield a final sample volume of 10 mL. Add 0.1 mL of iodine solution, mix well and allow to react for at least 1 minute. Add 5 mL of 1% Aliquat/MIBK solution. Dilute to volume with MIBK and mix.
- For petrol with a lead concentration of > 1 g/L, dilute with iso-octane before analysis.

Preparation of the atomic absorption spectrophotometer

Optimise the instrument for lead at 283.3 nm. Using the blank, adjust the gas mixture (acetylene/air) and aspiration rate to obtain an oxidising lean, blue flame. Aspirate the 20 mg/L lead working standard and adjust the instrument to achieve maximum response.

Standardisation and analysis

Aspirate the reagent blank and adjust the instrument to zero. Measure the absorbances of the 2, 5, 10 and 20 mg/L lead working standards. Aspirate the samples and record the absorbance values. Aspirate the blank between each sample measurement.

For instruments without a direct concentration readout, prepare a calibration curve by plotting the absorbance of the working standards against their concentrations (mg/L) on linear graph paper.

Calculations

Read the lead concentration in g/L directly from the instrument readout or calculate it by referring to the appropriate calibration curve:

$$\text{Lead concentration in petrol sample (g/L)} = (C \times V_1) \div (V_2 \times 1000)$$

where:

C = lead concentration (mg/L) of sample (as read from graph or instrument readout)

V₁ = final volume (50 mL)

V₂ = volume of sample petrol (mL)

Appendix VII: Test method 31 – Observation procedure for excessive air impurities: visible emissions

When an observer is determining if a vehicle is being used in breach of the clause limiting visible emissions, the following principles apply:

- The observer must be satisfied that the vehicle generating the visible emissions is correctly identified.
- The observer must be satisfied that the emissions are visible not just because of heat or the condensation of water vapour.
- The emissions must be continuously visible for more than 10 seconds.

The following details of the observation must be recorded:

- Length of time in seconds that the visible emissions were observed.
- Registration number of the motor vehicle under observation.
- Type of motor vehicle under observation.
- Colour and darkness, in the opinion of the observer, of the air impurities emitted.
- Location, date and approximate time of day that the observation was made.

In the case of observation of digital imagery produced by an Approved Vehicle Emission Recording System (AVERS):

When an observer of digital imagery produced by an AVERS is determining if a vehicle is being used in breach of the clause limiting visible emissions, the following principles apply:

- The observer must be satisfied that the vehicle generating the visible emissions is correctly identified.
- The observer must be satisfied that the visible emissions are visible not just because of heat or the condensation of water vapour.
- The emissions must be continuously visible on any digital video imagery produced by the AVERS for more than 10 seconds.

The following details of the observation must be recorded:

- Length of time in seconds that the visible emissions were observed.
- Registration number of the motor vehicle depicted in the digital imagery.
- Type of motor vehicle depicted in the digital imagery.
- Colour and darkness, in the opinion of the observer, of the air impurities which, by reference to the digital imagery, were emitted.
- Location, date and approximate time of day that the digital imagery was created.

For the purposes of this Test Method 31 the following is an Approved Vehicle Emission Recording Systems:

The hardware and software components of the system known as the Vehicle Emission Enforcement System operated by the Roads and Traffic Authority of NSW and installed to record digital imagery of vehicles emitting visible emissions in the M5 East Tunnel, Earlwood and to enable subsequent viewing of that imagery.

Appendix VIII: Test method 38 – Combination of air impurities from two or more sources

A combined source is a discharge point that combines discharge streams from two or more emission units, prior to discharge to the atmosphere. The procedure for calculating the alternative standard of concentration for a combined source is detailed in the following equation.

$$C_T = \frac{C_1 \cdot q_1 + C_2 \cdot q_2 + \dots + C_N \cdot q_N}{q_1 + q_2 + \dots + q_N}$$

where:

C_T = the alternative standard of concentration for the combined source

C_1, C_2, C_N = the standards of concentration that are applicable to each of N emission units

q_1, q_2, q_N = the volumetric flow rates of each of N emission units

Appendix IX: Other approved method 9 – ‘Coarse’ particulates

To determine ‘coarse’ particulates:

- determine solid particles (total) using TM-15
- **simultaneously** determine ‘fine’ particulates (PM_{10}) using OM-5, then
- subtract the result of OM-5 (‘fine’ particulates (PM_{10})) from the result of TM-15 (solid particles (total)) to determine ‘coarse’ particulates.

Sampling and analysis for solid particles (total) and ‘fine’ particulates (PM_{10}) must be carried out simultaneously using TM-15 and OM-5 respectively, to ensure the influence of process variations do not affect the results.

Appendix X: Test method sources

Australian Standard test methods

Available for purchase from:

Standards Australia
1 The Crescent
Homebush NSW 2140
(PO Box 1055, Strathfield NSW 2135)
Phone: 1300 65 46 46
Fax: 1300 65 49 49
Email: sales@standards.com.au
Website: www.standards.com.au

American Public Health Association test methods

Standard Methods for the Examination of Water and Wastewater, 20th Edition is available for purchase from:

Australian Water Association
PO Box 388
Artarmon NSW 1570
Phone: (02) 9413 1288
Fax: (02) 9413 1047
Email: bookshop@awa.asn.au
Website: www.awa.asn.au

American Society for Testing and Materials test methods

Available from Standards Australia (see above) or direct from:

American Society for Testing and Materials
100 Barr Harbor Drive
West Conshohocken PA 19428-2959, USA
Phone: 0011 1 610 832 9500
Fax: 0015 1 610 832 9500
Website: www.astm.org/index.html#

United States Environmental Protection Agency test methods

Available from:

USEPA
National Service Center for Environmental Publications
PO Box 42419
Cincinnati OH 45242, USA
Phone: 0011 1 513 489 8190
Fax: 0015 1 513 489 8695
Website: www.epa.gov/ttn/emc/ or www.epa.gov/ (for on-line ordering)
USEPA Method 0061: www.epa.gov/epaoswer/hazwaste/test/0061.pdf
SW-846 series: www.epa.gov/epaoswer/hazwaste/test/main.htm

California Environmental Protection Agency Air Resources Board

Available from:

Office of Communications
2020 L Street
Sacramento CA 95814, USA
Phone: 0011 1 916 322 2990
Fax: 0015 1 916 445 5025
Website: www.arb.ca.gov/testmeth/vol3/vol3.htm

Australian Design Rules test methods

The Federal Office of Road Safety publishes Australian Design Rules for motor vehicles. ADR 37/00 or 37/01 Emission Control for Light Vehicles is available from:

Federal Office of Road Safety
15 Mort Street
Canberra ACT 2600
(PO Box 594, Canberra ACT 2601)
Phone: (02) 6274 7111
Fax: (02) 6274 7922
Website: www.atsb.gov.au/fors/contact.htm

International Standard Organisation test methods

The International Standard Organisation test methods are available from:

International Organisation for Standardisation
Case Postale 56
CH-1211 Geneva 20
Switzerland

ISO catalogue information is available at www.iso.ch or from Standards Australia as detailed above.

Environment Canada test methods

The Environment Canada test methods are available from:

Environment Protection Publications
Technology Development Branch
Conservation and Protection
Environment Canada
Ontario K1A 0H3
Email: epspubs@ec.gc.ca
Website: www.ec.gc.ca/publications.cfm