GUIDELINES FOR ENVIRONMENTAL MANAGEMENT

A GUIDE TO THE SAMPLING AND ANALYSIS OF AIR EMISSIONS AND AIR QUALITY

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FOREWORD

Air quality continues to be among the top environmental concerns for Victorians. Industry can use an air monitoring program to address its environmental responsibilities, and its responsibility as a member of its local community. For some industries that may have significant emissions, a precautionary ambient air monitoring program should be undertaken to ensure that local air quality is assessed and action taken if ambient air quality objectives are exceeded. Industry performance monitoring enables plants to be managed properly to an adequate level of pollution control and licence compliance. In addition, the data can be useful in the design and implementation of clean technology systems and assist with identifying waste minimisation opportunities, and therefore cost savings.

This guide establishes best practice procedures for sampling and analysing environmental samples and is designed to assist licence holders, consulting analysts and industry with background information and guidance on performance monitoring for environmental purposes. The guidelines must be followed whenever testing or monitoring is undertaken for any purpose required by the *Environment Protection Act* 1970. The guidelines will also be invaluable to any company or agency that wishes to obtain an accurate assessment of the impact of its activities on the environment.

MICK BOURKE
CHAIRMAN

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1. INTRODUCTION

There are several possible reasons why stationary source emissions or ambient air quality are to be monitored. Frequently these are requirements of EPA licences or works approvals or are needed to meet the requirements of a Neighbourhood Environment Improvement Plan. However, the underlying reasons for monitoring would be related to one or more of the following:

- to determine the concentrations of pollutants in the environment or entering the environment from a specific source,
- to measure the efficiency of pollution control equipment,
- to allow process operators to control their processes within prescribed limits and to achieve optimum process efficiency,
- to provide data for emission inventories, and
- to assess the impacts of improvement strategies on the local environment.

The critical steps in any monitoring program (either source emission or ambient air) include, but are not restricted to:

- determining the objectives of the program,
- assessing a suitable sampling location or monitoring site,
- deciding on the measurements to be made (if not pre-stipulated),
- selecting an approved measurement method and appropriate equipment,
- obtaining representative samples,
- ensuring that the integrity of the sample is maintained prior to its presentation to the analytical device,
- documenting key steps in the sampling and analytical processes, including:
    - labelling of samples to be analysed,
    - recording process conditions related to emission source samples,
    - maintaining logs of instrument and equipment operating conditions,
- analysing the samples or sampled air accurately and precisely following approved analytical methods, and
- reporting results accurately and completely, and where appropriate providing informed interpretation of the results.

Most industrial operations have variable process conditions which change the characteristics and quantities of pollutants discharged to the environment. With care, these difficulties can be minimised and acceptable results produced. For large emission sources continuous emission monitoring may be required to provide a detailed record of emissions over time. In other circumstances, periodic testing may be sufficient, but this may also be needed to provide a check on the results produced from continuous monitoring.

For all monitoring or testing, a documented quality system is required. This would include:

- written procedures for the work undertaken,
- an outline of the training provided to staff who will operate the procedures,

- a description of the processes employed to check the quality of results, and
- procedures to be used in the event that the quality control checks identify a problem with the sampling and analysis.

This guide aims to provide general direction on appropriate selection of sampling locations, and sites, sampling and preservation of samples, storage and transport of samples, and analytical and quality assurance procedures for the testing and monitoring of source emissions and ambient air quality. The guidelines must be followed whenever testing or monitoring is undertaken for any purposes required by the *Environment Protection Act* 1970.

This guide is a companion document to *A Guide to the Sampling and Analysis of Waters, Wastewaters, Soils and Wastes* (EPA Publication 441).

2. EMISSIONS TESTING: PLANNING A SAMPLING PROGRAM

The primary purpose of industry performance monitoring is to provide information to the plant operator. This allows the operation of a plant to an adequate level of pollution control and assessment of compliance with the discharge licence. In addition, the data can be useful in the design and implementation of clean technology systems and to assist with identifying waste minimisation opportunities. Most often this will involve sampling from a stack or other designated discharge point and determining the characteristics of the emission gas stream.

Performance monitoring should provide timely, reliable and accurate information regarding the composition and rate of emission of waste to the environment. This will enable non-compliance with licence conditions to be promptly acted upon. These objectives can only be achieved if sampling and analysis methods are of a high standard.

Holders of EPA Licences have obligations to ensure that provisions for sampling, including sampling plane, access holes and work platforms meet the requirements specified in Australian Standard 4323.1 (1995). An EPA works approval is required prior to the construction of facilities. When EPA works approvals require physical or chemical measurements on discharges to air the applicant will be required to submit the following information as part of the works approval process:

- a statement of the objectives of the monitoring plan,
- monitoring plan details including: equipment to be used, methods of measurement and quality assurance program and relevant quality control steps for the monitoring,
- a scale diagram showing each discharge point with each testing access hole and the distances to upstream and downstream flow disturbances,
- a scale diagram showing the sampling platform and access, and
- the position and dimensions of all access holes.

Sampling of a licensed waste discharge must normally be undertaken at the frequency and locations specified in the licence subsequently issued by EPA.

If further in-plant investigational sampling and testing requiring the design and implementation of a complex program is deemed necessary, relevant specialist consultants or EPA personnel are available to assist.

Those engaged in sampling and analysis of air emissions require special expertise. It is most important that sampling personnel are trained and familiar with methods of obtaining representative samples, their handling and preservation, requirements of the analysis and any sampling and analysis limitations and importantly, safety issues. This applies whether an employee of the licensee is undertaking the sampling or a consultant laboratory has been contracted to do the work.

A detailed knowledge of the operation of the source(s) and any associated air pollution control devices is also important in obtaining a representative sample of the gas stream.

The choice of measurement methods needs to be compatible with the objectives of the monitoring program.

3. EMISSIONS SAMPLING

The sample(s) analysed must be representative of the gas stream being tested. Therefore, the objective of sampling is to ensure that the sampled gas stream is representative of either the total or a known portion of the source emissions. Unfortunately there is no single sampling method to cope with the variable and complex nature of source emissions. This section provides information and general guidance on aspects of sampling that must be considered prior to embarking on a sampling program.

Sampling requires special expertise and must be undertaken by trained personnel. Whenever sampling, monitoring or field measurements are undertaken it must be done within the framework of a well-documented quality system. This applies whether the analysing laboratory is responsible for the sampling, the licence holder monitors its own wastes or another organisation is contracted to conduct sampling.

The licence holder must ensure that sampling location, provisions and access meet the minimum requirements detailed in this guide. In some circumstances, the sampling location on a stack may not meet the minimum requirements specified in the Australian Standard 4323.1 (refer to Appendix A) because of existing design limitations. When this occurs, licence holders should contact EPA to determine whether test results from non-complying sampling locations will be acceptable or an alternative is required.

All laboratories performing sampling and analyses or on-site monitoring of emissions for licence compliance purposes must be accredited by the National Association of Testing Authorities (NATA) for all the tests concerned. This is a standard condition of all EPA Licences and works approvals. In special circumstances EPA may approve the use of a non-accredited laboratory or testing facility. Such approval must be sought prior to commencing a monitoring program.

3.1 Health and Safety Precautions

The risks associated with stack sampling must be carefully assessed prior to commencement of sampling. Appropriate risk management steps must be put in place. The risks may arise from any number of hazards associated with the tasks to be done and the physical conditions prevailing. Some of the hazards involved include:

- working at height or on temporary platforms,
- exposure to toxic, corrosive or hot gases,
- electrical hazards,
- trip hazards from cables,
- noise or heat from plant equipment,
- objects falling from work platform or into the duct, and
- flammability hazards.

When the sampler(s) are not employees of the organisation occupying the site, site management should be notified of impending tests and information sought on the site's safety policy and details of:

- requirements for safety work permits,
- location of emergency equipment and safety signs,
- location of refuge areas or muster points, and
- reporting procedures in the event of safety problems.

All site safety procedures should be followed. If the sampler assesses that there is unacceptable risk involved in taking samples, the testing should not proceed and site management should be advised.

3.2 Designing a Sampling Program

Planning a source emission test program requires that the objectives be clearly defined to ensure that the data will meet the stated objectives. Designing an adequate sampling program requires a good knowledge and understanding of the system to be sampled. The data user, sampling team and staff from the analysing laboratory should be involved in the planning stage if the program is to be successful. The following information should be acquired prior to sampling and testing:

- detailed information on the process conditions,
- the process conditions under which the test is required,
- the location of the sampling plane,
- provision of access holes and safe working platform,
- selection of the number of sampling points,
- safe access to the area,
- suitable sampling equipment,
- the availability of sufficiently sensitive and specific methods of analysis, and
- the distance from and capacity of the analytical laboratory.

There are wide variations in process conditions in most industrial plants, which may produce different characteristics and quantities of waste emissions. Strategies for sampling vary depending on whether the process is continuous, cyclic or batch and whether the results are to reflect peak, normal or any other designated plant operating conditions.

During the design stage of the sampling program personnel involved in emission sampling and analysis will need to consider the physical and chemical variability of the discharge. Sampling and analytical method validation will also be required to ensure the integrity of data where non-validated methods are used. Even in situations where validated methods exist, they may not be applicable to some emission sources.

In all test situations consideration must be given to:

- fluctuations in velocity, temperature or pollutant concentration due to uncontrollable variation in the process,
- moisture content (particularly wet stack gases),
- expected gas composition and likely interfering compounds,
- high vacuum, high pressure or high temperature gas streams, and
- corrosive or very reactive components.

3.2.1 Preliminary site inspection

Prior to testing, physical inspection of the source to be tested is used to establish the location of sampling access holes and determine accessibility and work platform requirements (including power and safety). Discussion with site personnel should include plant operating conditions and plant safety requirements for testing equipment and testing personnel.

The inspection should also determine if access holes are pre-existing, and that access hole covers can be removed for sampling (not corroded shut). Preliminary determinations of temperature, velocity, pressure and moisture content can then be made. If the sampling plane fails to meet the requirements necessary for obtaining a representative sample (Appendix A) then alternative sampling locations should be sought.

Following the inspections, and after considering the test objectives and plant operating conditions, a decision can be made on the sampling equipment and test procedures to be employed.

3.2.2 Numbers of samples and sampling times

A manual sampling program shall consist of a minimum of two test runs per pollutant with minimum sampling times specified in Table 1. The minimum sampling times do not apply to variable or batch processes. These cases may require sampling during an entire cycle or taking sufficient samples to characterise the gas stream to meet the objective of the sample program.

3.3 Manual Sampling

Virtually all stack tests require, as a minimum, the measurement of the following parameters to enable the calculation of mass emission rates of the waste in the discharge:

- gas velocity,
- gas pressure and temperature,
- gas composition and density,
- moisture and,
- volumetric flow rate.

To minimise the number of variables, tests should be conducted when there is constant flow through the duct. This should remain constant over the period of the test.

Sample conditioning is generally required to successfully transfer the analyte to the collection medium. This often incorporates filtration, heating, cooling or condensation to maintain the integrity of the sample.

3.3.1 Sampling emissions for particles

To obtain a representative sample of the gas stream containing solid or liquid particles, the sample must be withdrawn from the emission source at a rate such that the velocity and the direction of the gas entering the sampling nozzle is the same as the gas in the duct at the sampling point (isokinetic sampling). Generally, multi-point sampling at selected points across the sampling plane is performed. The number of points is dependent upon the cross-sectional area of the stack and distance of the sampling plane from flow disturbance within the stack (refer AS4323.1).

The degree to which a sample represents the particles in the total gas flow depends on:

- homogeneity of the gas velocity within the sampling plane,
- sufficient sampling points used across the sampling plane, and
- the maintenance of isokinetic sampling conditions.

Australian Standard 4323.2 describes an isokinetic gravimetric method for the determination of total solid particulate matter emitted from stationary sources. Solid particulate matter for this method is defined as particles remaining after oven conditioning at 105±5°C for a minimum of one hour. For some industries, consideration must be given to the temperature of the discharge and the effect that conditioning at 105±5°C may have on the collected particulate matter.

3.3.2 Sampling emissions for gases

Multi-point sampling is generally not required for sampling of gaseous emissions. However, in some situations, notably after the junction of several different streams, stratification of the gas stream will persist for some distance downstream.

A survey of a suitable constituent of the gas stream such as carbon dioxide or oxygen should be performed to determine the degree of stratification. In cases where stratification does not exist, single point sampling at one quarter the diameter across the stack, should be representative of the gaseous emission.

If stratification exists, the gaseous emission determination will require multi-point sampling techniques, unless an alternative sampling plane can be found.

3.3.3 Sampling emissions for organic compounds

The four environmental issues normally associated with stack emissions of organic compounds are:

- toxicity and potential for detrimental environmental or human health effects,
- odorous properties of the volatile species,
- potential to participate in photochemical reaction to produce oxidants,
- greenhouse gas or ozone-depleting potential.

Emissions of organic compounds to the environment may be in various phases or combinations of phases (solid, liquid or gas). Sampling techniques are therefore governed by the phase(s) of the compounds. To establish the most appropriate sampling method for determination of organic compounds from emission sources information on the composition and expected concentration is required. Details of the process operation are also required to establish whether the emission is intermittent, cyclic or continuous. Selection of an appropriate test method will be based on factors including:

- the chemical composition of the organic compounds emitted,
- the expected concentration range,
- the chemical and physical properties (boiling point, reactivity, solubility *etc.*), and
- the characteristics of the discharge (temperature, moisture *etc.*).

When the type and concentration of organic compounds in the discharge are unknown it is recommended that preliminary sampling and analysis be undertaken to identify and determine approximate concentrations of organic compounds beforehand to facilitate the selection of an appropriate test method. Some of the information can be obtained from literature surveys, plant personnel or previous experience with similar industrial processes.

3.3.4 Sampling organic emissions with solid sorbents

For multi-phase sampling of organics the common practice is to utilise a filter for solids and a solid sorbent cartridge for vapour-phase organics. This approach is used for sampling of semi-volatile organic compounds in USEPA Method 23 and USEPA SW-846 Method 0010.

EPA Method 4230 is generally applicable to hydrocarbons in the boiling point range 36 to 126°C and involves collection of a representative sample of stack gas on a solid sorbent tube. The method should not be used to sample very volatile organic compounds because low molecular weight hydrocarbons such as methane and propane break-through the absorption trap and are not measured.

3.3.5 Sampling organic emissions with bags/containers

If the discharge contains only very volatile gaseous organic compounds, gas samples may be collected in an inert sample container, then analysed by gas chromatographic techniques. With this sampling and analysis procedure very volatile organic compounds can be identified and quantified. Sampling using this technique with subsequent GC-FID (gas chromatograph – flame ionisation detector) or GC-MS (gas chromatography – mass spectrometry) analysis is generally used for:

- screening of emissions to identify unknown species, and
- organic compounds that are non-reactive volatile species.

For container samples, analysis must be completed within 48-hours of sample collection. This procedure is generally not applicable to higher molecular weight hydrocarbons due to the potential for loss in the sample container. A recovery evaluation is a mandatory requirement of container sampling. The recovery evaluation will include a spike of similar concentration to the sample and must remain in the container for the same duration that the collected sample was in the container.

3.3.6 Detection Limits

If it is known or likely that pollutant concentrations in the stack discharge will be close to the method detection limit (for example, Class 3 indicators) then attempts must be made to increase the pollutant concentration in the collected samples. There are a number of ways to increase the pollutant concentration above the detection limit including:

- increasing the sample volume
- concentrating the sample, and
- using more sensitive analytical techniques.

US Emission Measurement Technical Information Centre Guidance Document 038 (http://www.epa.gov/ttn/emc) describes a procedure for determining in-stack detection limits. The equation used for determining in-stack detection limits (ISDL) is:

$$ISDL = A \times \frac{B}{C}$$

Where A = analytical detection limit

B = amount of analyte

C = volume of stack gas sampled

eg The licence limit for chromium is 0.03 mg/m^3. The ISDL is predetermined to be 0.1 of the licence limit, 0.003 mg/m^3 (3.0E-6 mg/L). The sample will be prepared in 250 ml volumetric flask and the analysis method has a detection limit of 0.04 mg/L. What sample volume is required to obtain an ISDL of 0.003 mg/L?

$$C = A \times \frac{B}{ISDL}$$

$$= \frac{0.04mg/Lx0.25L}{3.0E-6mg/L}$$

= 3333 L

=3.33 m^3

3.4 Emission Monitoring

3.4.1 Semi-continuous emission monitoring

Instrumental gas analysers are often used in a semi-continuous (batch) monitoring mode to measure emissions for short periods of time (typically from 1-hour to several days). These systems are not permanently attached to the stack and generally stack gases are withdrawn from the discharge through a gas conditioning system to the instrumental analyser.

Because of the variety of parameters measured and techniques available in gas analysers it is not possible to specify performance specifications for all types of instrumental analysers. However, users must operate equipment according to the manufacturers instructions and be familiar with the characteristics of their analyser for their particular application. A requirement for instrumental analysers is that the following performance characteristics are assessed before use:

- response time,
- zero and span drift,
- detection limit,
- effect of interfering substances, and
- effect of temperature and pressure on instrument stability.

Quality assurance and quality procedures for operation of semi-continuous monitoring must meet the requirements contained in Appendix B of this guide.

3.4.2 Continuous emission monitoring

A continuous emission monitoring system (CEMS) is the total equipment necessary for the determination of a gas or particulate matter concentration or emission rate using instrumental analyser measurements and a correlation function, graph, or computer program to produce results in units applicable to the emission licence requirement.

Some licence holders are required to continuously monitor their process emissions. Obtaining a representative sample of the discharge is the most important factor in siting continuous emission monitoring equipment. Guidance is provided in AS 4323.1 on appropriate siting locations. Other factors for installation must also be considered. These include accessibility to the monitor and the sampling interface for routine maintenance and calibration. The size and number of access holes must be sufficient to accommodate the analyser as well as allowing parallel measurements against manual standard reference methods. If the monitor is to be located remote from the sampling location consideration needs to be given to response time, reactivity of sampled analyte and potential for sample loss.

There are two types of systems for continuous emission monitoring:

- extractive, and,
- in-situ.

Extractive systems involve continuous withdrawal of a sample from the gas stream. For gaseous components the extracted sample gas must be conditioned to prevent condensation and filtered to remove particle contaminants. Some conditioning systems include dilution with dry air to reduce the dewpoint of the sample gas to prevent condensation. An extractive system typically includes the following components: in-stack sampling probe, coarse in-stack filter, sample transport tubing, sample pump, moisture removal (dilution, refrigerant or diffusion), fine filter, analyser calibration system and data recorder.

In-situ monitoring means monitoring pollutants inside the stack under actual stack conditions. The monitoring path may be across the stack or part thereof.

3.4.3 Continuous emission monitoring for particles

There are a variety of continuous monitoring techniques for particles, these include methods that are based on light absorption, light scattering, charge transfer and beta attenuation techniques. To establish a calibration function between the particle monitoring system output and mass concentration, a series of manual stack tests using an approved method, for example Australian Standard 4323.2 (1995), should be performed over a range of emission rates and process conditions. The mean value of the CEM output measurements are correlated with the corresponding results from the manual stack tests to derive a calibration function for the particle monitoring equipment.

An appropriate field evaluation test program for the development of a calibration function between an automated particle monitoring system and a manual gravimetric test method is described in the International Standard 10155 (1995).

3.4.4 Continuous emission monitoring for organic compounds

The most common methods of continuously monitoring organic compounds are either chromatographic or spectrometric. The chromatographic system samples a portion of the stack effluent and delivers it either to a chromatographic system or directly to a flame ionisation detector (FID). If no chromatographic separation of compounds occurs, the low molecular weight hydrocarbons such as methane, propane etc. as well as other volatile organic compounds are measured by the detector as a single total response. The continuous analyser is normally calibrated against a methane or propane calibration gas and the results are expressed as parts per million carbon equivalents, although it is possible to calibrate the continuous monitor directly against a compressed gas standard e.g. hexane.

Note: For FIDs, the effect of the oxygen concentration of the monitored stack gas must be assessed. This effect can be reduced by using zero and span gas with the same oxygen concentration as the stack gas.

Spectrometric systems typically use differential optical absorption spectroscopy or fourier transform infrared spectroscopy techniques to monitor individual organic compounds within the discharge.

Commissioning of new equipment should include routine 24-hour zero and span cycles to demonstrate instrument stability. Calibration frequency may be relaxed to weekly following demonstration of satisfactory instrument stability. Instrument linearity checks are required on a six-monthly basis or after significant maintenance. Standard gases must have traceability to NIST standards and should be replaced or re-calibrated within two years of the initial certificate calibration date.

For each analyser a separate logbook (or equivalent) must be maintained, recording all relevant data related to the instrument. Chart records of the instrument output must be labelled on inspection with the time, date and operator's initials. Data records and logbooks must be kept for at least three years. Quality assurance and quality control procedures must meet the minimum requirements contained in Appendix B of this guide.

SAMPLING CHECKLIST

- ☐ **Conduct a preliminary site visit.**
- ☐ **Select an approved method and sampling equipment.**
- ☐ **Observe all safety precautions.**
- ☐ **Ensure plant is operating according to test requirements.**
- ☐ **Adhere to requirements of sampling method.**
- ☐ **Transport samples to laboratory as soon as practicable ensuring complete sample identification and description.**
- ☐ **Emission monitoring systems must be evaluated for performance.**

4. ANALYTICAL METHODS FOR EMISSIONS TESTING

4.1 Approved Laboratories (Testing Facilities)

EPA requires that all organisations conducting licence monitoring programs to be accredited by NATA for all the tests conducted. In special circumstances EPA may approve the use of a non-accredited laboratory or testing facility. Such approval must be sought prior to commencing a monitoring program.

For all methods used, the laboratory needs to demonstrate that it has expertise in sampling and that it can accurately analyse for the relevant air pollutant in the concentration range normally encountered.

This can be done by either:

- checking against standard reference materials, or
- proficiency tests.

It is also necessary to determine the precision (both repeatability and reproducibility), selectivity, limits of detection, linearity and applicable range of concentrations when using the method. An estimation of the uncertainty of measurement is also required by NATA (refer ISO 17025 and NATA 1999).

4.2 Approved Methods

EPA will specify in works approvals and licences the characteristics required to be monitored. Normally, the test method will be one specified in this guide although, on occasions, the particular test method will also be specified in the works approval or licence.

Only methods chosen from Table 1 or the approved references listed should be used. For statutory testing, methods not based on any of the methods in the approved references can only be used with prior approval of EPA. When seeking approval from EPA, validation of the proposed method must be demonstrated before approval can be granted. The procedures that should be followed for method validation are available in *Requirements for the Format and Content of Test Methods and Recommended Procedures for the Validation of Chemical Test Methods* [NATA Technical Note No.17] (NATA 1997).

The approved standard references* are:

1. *Methods of Air Sampling and Analysis* 3rd Edition American Public Health Association (1989), Washington DC 20036.
2. *Test Methods for Evaluating Solid Waste,* US Environmental Protection Agency (1986) Publication SW-846, Third Edition, 1996 (plus First and Second Updates, 1988 and 1992) - URL address: http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm.
3. *Methods for the Determination of Toxic Organic Compounds in Air - EPA Methods*, Winberry W.T, Murphy N.T., Riggan R. M, Noyes Data Corporation, USA, Published 1990.
4. *NIOSH Manual of Analytical Methods*, 4th Edition Published by the US Dept. of Health.

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* The latest editions of these references at the time of publishing this guide are referenced. Where they are superseded, the most recent edition should be used.

5. Relevant Australian Standards and International Standards prepared by the International Organisation for Standardisation (catalogue of publications available from Standards Australia, 19-25 Raglan Street, South Melbourne VIC 3205 or web site www.standards.com.au).

6. *Quality Assurance Handbook for Air Pollution Measurement Systems Volume III: Stationary Source Specific Methods* United States Environmental Protection Agency (1993), USEPA, (Publication No EPA 600/4-77-027b) Cincinnati, Ohio, 45268.

Web Site Information

The EPA's web site can be found at the following URL address: http://www.epa.vic.gov.au. This site can be used to:

- download a copy of EPA Publication 440,
- download a copy of EPA Victoria methods for source emission testing, and
- access other web sites related to ambient and source emission testing:

  - National Environment Protection Council Peer Review Technical Papers: http//www.ephc.gov.au/prc

  - USEPA Emission Measurement Centre:

    http://www.epa.gov/ttn/emc/

  - USEPA Ambient Monitoring Technology Information Centre: http://www.epa.gov/ttn/amtic

TABLE 1: EPA Approved Methods for Analysis of Air Emissions

PARAMETER	METHOD (Manual)	MINIMUM SAMPLING TIME (min) PER RUN
Selection of sampling positions	AS 4323.1	
Water vapour	USEPA Method 4	
	EPA(Vic) Method 3040 (discharges<100°C)	
Velocity and volume flow rate	ISO Method 10780	
Gas density	USEPA Method 3	
Total nitrogen oxides	USEPA Method 7D	30
Sulfur dioxide	ISO Method 11632	30
Sulfur dioxide and sulfur trioxide	USEPA Method B8	60
Particulate	AS 4323.2	60
Odour	AS 4323.3*	
Hydrogen chloride	USEPA Method 26	30
Total reduced sulfur	USEPA Method 16A	60
Fluoride	USEPA Method 13B	60
Total water soluble fluoride	EPA(Vic) Method 3142	30
Heavy metals	USEPA Method 29	120
Volatile organic compounds	EPA(Vic) Method 4230	15
Volatile organic compounds	USEPA Method 18	15
Polychlorinated dibenzo-p-dioxins/furans	USEPA Method 23	120
Polycyclic aromatic hydrocarbons	USEPA SW-846 Method 0010	120
Aldehydes and ketones	USEPA SW-846 Method 0011	60
Instrumental Analyser	**Method (Continuous)**	
Oxygen	USEPA Method 3A	60
Carbon dioxide	USEPA Method 3A	60
Carbon monoxide	USEPA Method 10	60
Total nitrogen oxides	USEPA Method 7E	60
Sulfur dioxide	USEPA Method 6C	60
Total hydrocarbons	USEPA Method 25A	60
Leak detection of volatile organic compounds	USEPA Method 21	
Continuous Emission Monitoring		
Volume flow rate (automated)	ISO Method 14164	
Mass concentration of particles	ISO Method 10155	
Oxygen	ISO Method 10396	
Carbon dioxide	ISO Method 10396	
Carbon monoxide	ISO Method 10396	
Total nitrogen oxides	ISO Method 10396 ISO Method 10849	
Sulfur dioxide	ISO Method 10396 ISO Method 7935	

* Refer to Appendix C for EPA Victoria guidelines for use of AS 4323.3.

4.3 Approved methods for organic compounds

Selection of an approved method of testing organic compounds and interpreting results is often confusing for a variety of reasons:

- The terms, volatile organic compounds (VOC), total organic compounds (TOC) and non-methanic hydrocarbons (NMHC) are often incorrectly applied interchangeably.
- All test methods for organic compounds have limitations that restrict their application.
- Some methods report results in terms of the individual compounds in a mixture and others report an equivalent concentration of a reference compound (e.g. hexane).

Future EPA licences will refer only to volatile organic compounds defined as "any chemical compound based on carbon with a vapour pressure of at least 0.010kPa at 25°C or having a corresponding volatility under the particular conditions of use. These compound(s) may contain oxygen, nitrogen and other elements, but specifically excluded are CO, CO_2, carbonic acid, metallic carbides and carbonate salts."

The State environment protection policy (Air Quality Management) lists the design criteria for a range of hazardous compounds (Class 2 and Class 3 indicators) used in the assessment of new or expanded sources of industrial emissions. Test methods for organic compounds listed as Class 2 and Class 3 indicators should be selected in accordance with this guide.

Class 2 indicators

If the emission contains only a few organic compounds that can be easily separated by gas chromatography, then individual species should be quantified. If the number of organic compounds is 10 or less, then individual compounds should be identified and quantified (compounds comprising less than 1% of the total need not be determined). Generally, if the emission consists of a complex mixture of organic compounds containing greater than 10 species, then the top ten compounds representing the highest concentration of Class 2 indicators (>1% of the total) should be identified and quantified. The remaining VOCs should be determined and expressed as an equivalent of the major volatile organic compound (VOC) in the emission (Table 2).

Class 3 indicators

All Class 3 indicators must be identified and quantified. If the emission contains semi-volatile aerosol, isokinetic sampling methods must be employed. Both the particle and gaseous fractions must be determined. The main semi-volatile compounds of interest are polycyclic aromatic hydrocarbons (PAHs) and dioxins and furans. For PAH, results are normally expressed as the USEPA 16 individual priority PAHs. For chlorinated dibenzo-dioxins and chlorinated dibenzo-furans, results are reported separately, with each level of chlorination from the tetra to octa-chloro substitutions also reported separately. Within each level of chlorination all those compounds including chlorine substitution at the 2,3,7,8 positions are reported individually. Those compounds not substituted at the 2,3,7,8 position are reported as a composite group (*e.g.* non-2,3,7,8 hexachlorinated dibenzo-dioxins). Reporting of individual congeners allows the computation of *total toxic equivalents* and gives an indication of the classes of compounds present.

VOCs unclassified in the SEPP(AQM) Schedule A

Unclassified VOCs are treated in the same way as Class 2 indicators, that is, if the number of VOCs is 10 or less, then individual compounds should be identified and quantified (compounds comprising less than 1% of the total need not be determined). If the emission consists of a complex mixture of organic compounds containing greater than 10 species, then the top 10 compounds representing the highest concentration of unclassified indicators (>1% of the total) should be identified and quantified. The remaining VOCs should be determined and expressed as an equivalent of the major VOC in the emission (Table 2).

Table 2

Class of organic constituents	**Recommended procedure**
Class 3	Quantify all Class 3 indicators.
Class 2 (with design criteria for odour)	Quantify Class 2 indicators that are highly odorous.
Mix of Class 3 and Class 2	Quantify all Class 3 indicators. Quantify top 10 Class 2 indicators >1%. The residual VOCs are expressed as the equivalent of the major compound.
Class 2 (<10 compounds)	Quantify all Class 2 indicators >1%.
Class 2 (>10 compounds)	Quantify top 10 Class 2 indicators >1%. The residual VOCs are expressed as the equivalent of the major compound.
Mix of Class 2 and VOCs unclassified in SEPP(AQM) Schedule A	Quantify Class 2 indicators and unclassified VOCs >1% (up to 10 compounds). The residual VOCs are expressed as the equivalent of the major compound.
VOCs unclassified in SEPP(AQM) Schedule A	Quantify VOCs >1% (up to 10 compounds). The residual VOCs are expressed as the equivalent of the major compound.

The following information on methods for determining VOCs is intended to provide general guidance for selection of an approved method for sampling and analysis. The methods may not apply to all test situations, especially in stack environments where high temperature and high humidity conditions exist.

VOCs - USEPA Method 18

This method may be used for pre-survey screening or analysis of VOC emissions. It is not applicable to compounds that:

- are polymeric (high molecular weight)
- polymerise before analysis
- have very low vapour pressures at stack or instrument conditions.

The VOCs are separated by gas chromatography and individually quantified by flame ionisation, photoionisation, electron capture or other appropriate detection principles.

VOCs - EPA Method 4230

This method uses solid sorbent traps and may be used for analysis of hydrocarbons in the boiling range 36 to 126°C. The method is not applicable to very volatile organic compounds because of the potential for break-through. The method has limitations for high temperature and high humidity stack conditions.

Polycyclic aromatic hydrocarbons - USEPA SW-846 Method 0010

This method is used for the isokinetic sampling and analysis of PAHs. Analysis is by USEPA SW-846 Method 8270D and utilises gas chromatography and mass spectrometry.

Aldehydes and ketones - USEPA SW-846 Method 0011

This method is used for the analysis of aldehydes and ketones and can be used for isokinetic sampling of formaldehyde, acetaldehyde, acetophenone, isophorone and propionaldehyde. The method utilises an aqueous solution of 2,4-dinitrophenylhydrazine as the derivitising agent. Analysis is by high pressure liquid chromatography and UV detection according to USEPA SW846 Method 8315A.

Polychlorinated dibenzo-p-dioxins/furans - USEPA Method 23

This method is used for the isokinetic sampling and analysis of PCDD and PCDF congeners utilising an XAD-2 sorbent trap. Analysis is by high resolution mass spectrometry.

4.4 Quality Assurance

A laboratory quality assurance system is a requirement of NATA accreditation, and laboratories should seek to constantly assess their competence by participating, whenever possible in inter-laboratory proficiency programs.

Additional details on quality assurance and quality control are presented in Appendix B.

TEST METHODS CHECKLIST

☐ **Select the appropriate method from those approved in this guide.**

☐ **Ensure that an adequate Quality Assurance regime is in place for field sampling and in the laboratory.**

☐ **Report test data on NATA-endorsed reports, where appropriate.**

5. PLANNING AN AMBIENT AIR MONITORING PROGRAM

The first step in developing a monitoring plan is to clearly define the objectives of the monitoring. This can be done by addressing questions such as:

- What is the reason for ambient air monitoring?
- What questions need to be answered by this monitoring program?
- What pollutants or environmental indicators need to be monitored in order to provide the information required, and
- What are the intended uses of the monitoring data?

Once the objectives are clearly defined the following information may be sought.

- The number and type of air pollutants to be measured and their expected concentrations.
- The number of sites required and where they are to be located.

  Sites should have:

  - electricity
  - security
  - access (for both people and service vehicles)
  - approval for use and security of tenure.
- The sampling time and frequency of measurements.
- The length of the sampling program and whether it meets the objective of the monitoring program.
- Approved sampling and analysis methods.
- What resources are required and their availability.
- A communication strategy to explain to stakeholders the design, operation and results from the monitoring program.

To assist in interpreting air quality data, meteorological measurements (temperature, wind speed and wind direction) are normally required in the area in which air quality measurements are conducted (refer to AS 2923, 1987).

Good QA/QC procedures are required if the air quality data collected are to be of sufficient quality to allow comparison with relevant air quality standards and objectives. Based on these comparisons, judgements about environmental quality and exposure to air pollutants can be made. As a minimum requirement, all laboratories conducting ambient air monitoring programs must be accredited by the NATA for all the tests concerned.

Prior to embarking on a major air monitoring program it may be beneficial to conduct a limited survey to establish whether a major intensive study is required. A limited survey might involve collecting a small number of samples to gain insight on the presence and magnitude of pollutants believed to be of concern. This survey should be conducted when pollutant concentrations are expected to be at their highest.

Staff involved in sampling and analysis of ambient air quality require specialised expertise and must be appropriately trained and supervised.

PROGRAM DESIGN CHECKLIST

- ☐ **The key to a good program design is to first determine the objectives of the monitoring program.**
- ☐ **Seek approval for the monitoring plan at the EPA works approval stage.**
- ☐ **Collect any background historical air quality monitoring and meteorological data for the study area.**
- ☐ **If appropriate, obtain information about local emission sources and undertake computer modelling to estimate ground level concentrations for nearest receptors.**
- ☐ **Use approved sampling and analysis methods.**

6. SAMPLING AMBIENT AIR

Measurements can be made using batch (time-integrated sampling) or continuous monitoring techniques. Continuous monitors are preferred for most long-term monitoring. It should be noted that ambient air quality measurements may involve determinations of particles as well as gases. Sampling for particles has traditionally been performed using manual filter-based samplers. If continuous analysers are used for particle monitoring, and sample conditioning by heating is involved, consideration should be given to how the pre-heating of the sampled gas stream may affect the measurements.

For most source-related air monitoring programs natural or background sources of air pollutants should be considered. In some cases, background contributions to local air quality may be significant and need to be assessed.

6.1 Site Selection

With any air monitoring program the selection of an appropriate sampling site is of paramount importance. Selection of an ambient air monitoring site should be based on the guidance provided in *Guide for the siting of sampling units*, Australian Standard AS 2922. However, there may be occasions when the requirements of the program will require some compromise between what is required by AS 2922 and what is achievable in practical terms. Such compromises, or deviations from AS 2922, need to be noted in monitoring reports.

Most air monitoring programs require monitoring of meteorological conditions because of the influence they have on both local and regional air quality. Siting criteria for meteorological sensors should be based on the guidance provided in *Guide for measurement of horizontal wind for air quality applications*, Australian Standard AS 2923.

6.2 Sample Systems

The selection of a sampling system depends on the type and nature of air pollutant to be measured.

For gases, consideration should be given to the reactivity of the gas:

Sample lines must be made of inert material (e.g. glass, polytetrafluoroethylene), be as short as possible and have sufficient flow to minimise residence time (<2 seconds) and hence minimise loss of sample. Sample lines must be kept clean and free of water or condensation. The sampling system must be regularly examined and tested for leaks.

For particles, sample line losses due to impaction on the surface of the sample line or electrostatic charge effects can be significant. Therefore, sample collection should be performed directly to the collection or analysis system. Sample lines, if used, must be short, with no bends and constructed of a material (such as stainless steel) that will not develop a static charge.

For those who are interested in monitoring air quality in their local community but do not have the resources to purchase and operate approved air pollution analysers, Appendix E of this guide provides some guidance on screening methods for assessment of air quality.

SAMPLING CHECKLIST

☐ **Consideration should be given to the possible contribution of background sources of air pollutants.**

☐ **Select ambient air monitoring sites in accordance with AS2922 and siting of meteorological monitoring equipment according to AS2923.**

☐ **Sampling lines must be constructed from materials that will not affect the integrity of the sample air being monitored.**

7. MEASUREMENT METHODS FOR AMBIENT AIR MONITORING

7.1 Approved Laboratories (testing facilities)

The same requirements as for emissions testing (see Chapter 4) apply to the attributes required of organisations conducting ambient air monitoring programs. In summary:

- laboratories and testing facilities must be accredited by NATA for all the tests conducted,
- they need to demonstrate that they have expertise in sampling and that they can accurately analyse for the relevant air pollutant in the concentration range normally encountered, and
- performance should be verified by checking against standard reference materials and participating in proficiency tests.

In special circumstances EPA may approve the use of a non-accredited laboratory or testing facility. Such approval must be sought prior to commencing a monitoring program.

Also, as with emissions testing, it is necessary to determine the precision (both repeatability and reproducibility), selectivity, limits of detection, linearity and applicable range of concentrations of the measurement methods, as used. An estimation of the uncertainty of measurement is also required by NATA (refer ISO 17025 and NATA 1999).

7.2 Approved Methods

EPA will normally specify the parameters/pollutants required to be monitored by licence and works approval holders. Normally, the test method will be one specified in this guide although, on occasions, the particular test method will also be specified in the works approvals and licences.

When monitoring for Class 1 indicators approved methods listed in Table 3 should be used. Other monitoring methods may be used if:

- Calibration and validation studies show the accuracy and precision of the other method are comparable with the relevant Australian Standard method.
- The equipment used is calibrated to the standard required under the relevant Australian Standard method or an equivalent, internationally recognised method.
- The equipment provides equivalent information for assessment purposes.

TABLE 3: EPA Approved Methods for Ambient Air Monitoring

SITING/METEOROLOGY/POLLUTANT	METHOD
Siting of sampling units	AS2922#
Measurement of horizontal wind	AS2923
Sulfur dioxide	AS3580.4.1
Nitrogen dioxide	AS3580.5.1
Oxidant	AS3580.6.1
Carbon monoxide	AS3580.7.1
Particle matter less than 10 micrometres (PM10)	AS3580.9.6, AS3580.9.7 and AS3580.9.8*
Deposited matter	AS3580.10.1
Volatile organic compounds	AS3580.11.1
Visibility reducing particulates	AS3580.12.1.
Total suspended particulates	AS2724.3
Lead	AS2800

AS = Australian Standard

* Adjust PM10 TEOM data with a temperature adjustment according to the National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 10.

7.3 Quality Assurance

A laboratory quality assurance system is a requirement of NATA accreditation, and laboratories should seek to constantly assess their competence by participating, whenever possible in inter-laboratory proficiency programs.

Guidelines on minimum quality procedures for ambient air monitoring for statutory purposes are detailed in Appendix B.

TEST METHODS CHECKLIST

☐ **Select the appropriate method from those approved in this guide.**

☐ **Ensure that an adequate quality assurance regime is in place for field sampling and in the laboratory.**

☐ **Report test data on NATA-endorsed reports, where appropriate.**

8. REPORTING AND REVIEW RESULTS

8.1 Analytical Report

A NATA-endorsed test report is the final product of sampling and analysis. It must contain sufficient information for the end user to make a critical evaluation of its contents. The end user may be a licence holder, a community group involved with a neighbourhood monitoring program or, indeed, EPA. The report format should comply with the NATA requirements. In particular, the following information should be reported (where relevant) with the analytical result for each parameter determined. This information is either provided by the person taking the sample or by the laboratory conducting the analysis or monitoring:

- date and time of sampling,
- identification of samples taken (including sample description, sample number and unique laboratory number),
- details of any sample preservation,
- reference to analytical method used,
- estimate of the measurement uncertainty for the results,
- date of determination,
- results in the appropriate units,
- notations of any deviation from the standard method, and
- any factor that may have affected reliability of the results.

Furthermore, for emission source testing results, information should be provided on:

- identification of the source tested,
- the location of the sampling plane with respect to the nearest upstream and downstream flow disturbances, and
- details of source operating conditions during sampling.

Abbreviations should be defined and the format of reporting should also meet any requirements specified in the standard method. NATA accreditation now also requires an estimate of the uncertainty of the measurement to be stated.

Analysts should not report results to a greater number of significant figures than is justified by the accuracy of the test.

The limit of detection for each analyte should be quoted with quantitative test results. Concentrations below the limit of reporting should be quoted as a 'less than' (<) figure.

For emission monitoring, results are normally reported as g/min for emission discharge rates and mg/m^3 or parts per million (ppm) for concentrations. All volumes and concentrations should normally be reported as dry (except for odour which is normally reported wet), at a temperature of 0°C and at an absolute pressure of 101.3 kilopascals. An EPA licence may also specify a reference gas level to which a result must be corrected (*e.g.* 7% oxygen for testing of oxides of nitrogen).

8.2 Reviewing Data

All results should be reviewed on receipt by the person or organisation requesting the analysis, and action taken if abnormal or unexpected results are detected.

When reviewing data:

- reported results should be compared with those expected and unusual results queried,
- results should be compared with historical data,
- problems should be identified e.g. unusual plant operating conditions, and
- appropriate action must be taken to address the problems identified.

In the case of emission source testing or monitoring, any analytical results which exceed the licence emission limits must be reported to EPA immediately in writing (preferably by fax) and in accordance with licence conditions. This report should contain a summary of the reasons leading to the exceedence and action taken to bring the process back into licence compliance.

8.3 Routine Reporting to EPA

Monitoring results are usually compiled annually and sent to EPA's regional office by the licence holder or organisation responsible for the monitoring. Results should be submitted in the form of a summary report, endorsed by the licence holder, which includes:

- a signed summary sheet(s) of the emission testing carried out. An example summary sheet is included in Appendix D,
- a written description of the status of the plant served by the particular discharge point(s) during the sampling period,
- any relevant operating parameters,
- any maintenance or corrective actions taken as a result of the initial or subsequent non-complying monitoring result, and
- a review of the circumstances that led to the non-complying episode, and recommendations considered to minimise the probability of the situation recurring.

If in doubt about the level of information to be submitted contact EPA.

8.4 Record Keeping

Individual analytical results and reports must be kept for three years (although not submitted unless requested). EPA will review the results submitted and may request further information, access to laboratory records or may initiate its own sampling if necessary.

REPORTING CHECKLIST

- ☐ **Review data promptly and take any necessary action.**
- ☐ **Advise EPA IMMEDIATELY in writing (by fax) if a result exceeds licence conditions.**
- ☐ **Review options for waste minimisation.**
- ☐ **License holder to summarise monitoring results, endorse and submit report to EPA regional office.**
- ☐ **Hold all analysis results for three years**

9. REFERENCES

Australian Standard 2800 (1985) Ambient air - Determination of particulate lead - High volume sampler gravimetric collection - Flame atomic absorption spectrometric method.

Australian Standard 2922 (1987) Ambient air-Guide for the siting of sampling units

Australian Standard 2923 (1987) Ambient air - Guide for measurement of horizontal wind for air quality applications.

Australian Standard 3580.4.1 (1990) Methods for the sampling and analysis of ambient air - Determination of sulfur dioxide - Direct reading instrumental method.

Australian Standard 3580.5.1 (1993) Methods for the sampling and analysis of ambient air - Determination of oxides of nitrogen - Chemiluminescence method.

Australian Standard 3580.6.1 (1990) Methods for the sampling and analysis of ambient air - Determination of ozone - Direct reading instrumental method.

Australian Standard 3580.7.1 (1992) Methods for the sampling and analysis of ambient air - Determination of carbon monoxide - Direct reading instrumental method.

Australian Standard 3580.8.1 (1990) Methods for the sampling and analysis of ambient air - Determination of hydrogen sulfide - Automatic intermittent sampling - Gas chromatographic method

Australian Standard 3580.9.6 (1990) Methods for the sampling and analysis of ambient air - Determination of suspended particulate matter - PM10 high volume sampler with size selective inlet - Gravimetric method.

Australian Standard 3580.9.7 (1990) Methods for the sampling and analysis of ambient air - Determination of suspended particulate matter - PM10 dichotomous sampler - Gravimetric method.

Australian Standard 3580.9.8 (2001) Method 9.8 Methods for the sampling and analysis of ambient air - Determination of suspended particulate matter - PM10 continuous direct mass method using a tapered element oscillating microbalance analyser.

Australian Standard 3580.10.1 (1991) Methods for the sampling and analysis of ambient air -

Determination of particulates - Deposited matter - Gravimetric method.

Australian Standard 3580.12.1 (2001) Method 12.1 Determination of light scattering - Integrating nephelometer method.

Australian Standard 3580.13.2 (1991) Methods for the sampling and analysis of ambient air - Determination of fluorides - Gaseous and acid soluble particulate fluorides - Manual double filter paper sampling.

Australian Standard 4323.1 (1995) Stationary source emissions. Method 1: *Selection of sampling positions* ISBN 0 7262 9885 9

Australian Standard 4323.2 (1995) Stationary source emissions. Method 2: Determination of total particulate matter - Isokinetic manual sampling-Gravimetric method

Australian Standard 4323.3 (2001) Stationary source emissions. Part 3 : Determination of odour concentration by dynamic olfactometry.

Australian Standard ISO/IEC 17025 (1999) *General requirements for the competence of testing and calibration laboratories*. ISBN 0 7337 3304 2.

International Standard ISO 10155 (1995) Stationary source emissions *Automated monitoring of mass concentrations of particles* - Performance characteristics, test methods and specifications.

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

International Standard ISO 14164 (1999) Stationary source emissions *Determination of the volume flow rate of gas streams in ducts* - Automated Method.

NATA 1994. *Technical Note No. 19, Liquid-in-glass Thermometers – Selection, Use and Calibration.* National Association of Testing Authorities.

NATA 1995a. *Guide to Development of a Quality System For a Laboratory*. National Association of Testing Authorities.

NATA 1995b. *Technical Note No. 23, Guidelines for Quality Control in the Analytical Laboratory*. National Association of Testing Authorities.

NATA 1997. *Technical Note No. 17, Format and Content of Test Methods and Procedures for Validation and Verification of Chemical Test Methods*. National Association of Testing Authorities.

NATA 1999, *Assessment of Uncertainties of Measurement for Calibration and Testing Laboratories*. R.R. Cook, National Association of Testing Authorities

National Environment Protection (Ambient Air Quality) Measure (2001) *Collection and Reporting of TEOM PM10 Data* Technical Paper No. 10.

State Environment Protection Policy (Air Quality Management) ([2001) Victoria Government Gazette No.S 240 Victorian Government Printer.

10. GLOSSARY OF TERMS

Access hole - a hole in the stack or duct at the extremity of a sampling traverse, through which sampling or monitoring equipment is inserted.

Continuous emission monitor - a system that may be attached to a stack or duct to continuously measure and record the concentration of waste passing through the stack or duct.

Class 1 indicator - a substance which is common or widely distributed and is established as an environmental indicator in the State environment protection policy (Ambient Air Quality), and may threaten the beneficial uses of both local and regional air environments.

Class 2 indicator - a waste that is a hazardous substance that may threaten the beneficial uses of the air environment by virtue of its toxicity, bio-accumulation or odorous characteristics.

Class 3 indicator - a waste that is an extremely hazardous substance that may threaten the beneficial uses of the air environment due to its carcinogenicity, mutagenic, teratogenic, highly toxic or highly persistent characteristics.

Detection levels

> *Method detection* level- lowest concentration of an analyte in a sample that can be detected, when processed through the complete method. Three times the standard deviation for the analysis of the blank samples is used. For instrumental techniques, a signal-to-noise ratio of 3:1 is acceptable.
>
> *Limit of reporting* (*limit of quantitation*)– Is the lowest concentration of an analyte that can be determined with acceptable precision (repeatability) and accuracy under the stated conditions of the test. The limit of reporting is usually calculated as 10 times the method detection level.

Diameter - the internal diameter of a circular stack or the hydraulic diameter (four times the stack internal area divided by the stack perimeter) of a non-circular stack.

Dioxins - a group of polychlorinated dibenzo-dioxins and polychlorinated dibenzo-furans with different levels of chlorination and positioning of chlorine atoms.

Extractive sampling - involves the transport of a volume of the stack gas outside the source environment, removal of interfering materials and maintenance of the gas concentration throughout the sampling system for subsequent analysis by appropriate instrumentation.

NEIP – Neighbourhood environmental improvement plans provide a mechanism to enable all parts of the community to come together and address local environmental problems.

Gas stream - a gaseous mixture that may carry particulate matter, pollutants and waste in a stack or duct.

GC/FID - gas chromatography/flame ionisation detector - an analytical technique used for the separation and identification of organic mixtures.

GC/MS - gas chromatography/mass spectrometry - an analytical technique used for the separation and identification of organic mixtures.

In-situ sampling - does not involve removal of a sample from the stack environment, the measurements are made on-site without transport or extraction.

Instrumental analyser - an analyser that is not permanently attached to a stack or duct and is used to continuously monitor concentrations of waste for relatively short durations e.g. hours.

Intervention level - a numerical value for an indicator which if exceeded may trigger development of a neighbourhood environment improvement plan.

Isokinetic sampling - sampling at a rate such that the velocity and direction of the gas entering the sample nozzle is the same as that of the gas stream being sampled.

Precision - variability between repeated tests, caused by random errors. Two measures of precision are:

(i) repeatability precision - tests are performed under conditions that are as constant as possible.

(ii) reproducibility precision - tests are carried out in different laboratories with different operators and equipment.

Quality assurance – all of the actions, procedures, checks and decisions undertaken to ensure the accuracy and reliability of analysis results.

Quality control – parts of the quality assurance which serve to monitor and measure the effectiveness of other quality assurance procedures compared with previously decided quality objectives.

Representative sample - a sample which has the same characteristics as the gas stream passing the sampling plane at the time of sampling.

Sampling plane - the plane normal to the axis of the stack or duct at which sampling takes place.

Sampling point - one of a number of specific locations on a sampling traverse at which sampling takes place.

Sampling traverse - an imaginary line in the sampling plane along which the sampling points are located.

Stack and duct - a structure through which the gas stream passes.

VOC - any chemical compound based on carbon chains or rings (and also containing hydrogen) with a vapour pressure greater than 0.010kPa at 25°C. These compound(s) may contain oxygen, nitrogen and other elements, but specifically excluded are CO, CO_2, carbonic acid, metallic carbides and carbonate salts.

APPENDIX A: CRITERIA FOR ASSESSMENT OF STACK SAMPLING PLANES

This Appendix defines the minimum acceptable criteria for sampling of stack emissions for licence compliance in Victoria. The aim is to provide clear guidelines for licence holders to evaluate stack sampling provisions for their suitability for testing and reporting to the EPA on NATA endorsed reports. The suitability of sampling planes should be considered at the design stage before submitting a works approval application. It is the responsibility of the licence-holder to ensure that sampling planes and access points comply with the requirement of the guide.

Particulate Sampling

The largest number of non-compliance issues are related to multi-point isokinetic sampling of particles/aerosols and velocity measurements.

Ideal or Satisfactory Sampling Planes

An ideal sampling position is likely to exist at least eight diameters downstream and two to three diameters upstream from a flow disturbance. In most cases a satisfactory sampling plane will be found at minimum distances listed in Table 1 of Australian Standard 4323.1. Sampling planes for isokinetic multi-point sampling must comply with these criteria, which are:

- minimum distances to flow disturbances (Table 1 AS4323.1),
- the stack must have the required number of access holes to permit sample traverses for the dimensions of the stack being tested (Tables 3 and 4, AS 4323.1),
- velocity and temperature surveys must meet the criteria listed in Clause 4.1(a) to (f), AS 4323.1,
- test reports must state the distance to the nearest upstream and downstream flow disturbances.

Non-Ideal Sampling Plane

Non-ideal sampling planes may be considered as those sampling planes that are closer to flow disturbances than those listed in Table 1 AS 4323.1, but are at least one duct diameter upstream of the flow disturbance or greater than or equal to two duct diameters downstream of the flow disturbance.

AS 4323.1 recognises that some latitude is required for sampling planes that cannot meet the requirements of Table 1. However, allowance for non-ideal sampling positions is limited and steps must be taken to improve precision by increasing the number of sampling points.

In the event that non-ideal sampling planes are used, the following criteria must be met:

- the stack must have the required number of access holes to permit sample traverses for the dimensions of the stack being tested (Tables 3 and 4, AS 4323.1),
- velocity and temperature surveys must meet the criteria listed under Clause 4.1(a) to (f), AS 4323.1),
- a greater number of sampling points (Clause 4.2, AS 4323.1) must be used to improve accuracy caused by the non-ideal nature of the sampling plane.

For gaseous sampling, when velocity and volume flow rate are also to be determined, the same criteria used for isokinetic sampling must be applied.

Test reports must clearly indicate if a non-ideal sampling plane was used and details of both the type and extent of criteria deviation must be reported. The use of a non-ideal sampling plane may reduce the precision of results, and steps such as increasing the number of sampling points for isokinetic tests must be adopted according to the Australian Standard 4323.1.

Non-Compliant Sampling Planes

Non-compliant sampling planes may be considered as sampling planes that are closer to flow disturbances by less than one duct diameter upstream of the flow disturbance or less than two duct diameters downstream of the flow disturbance and do not meet all the criteria listed in Clause 4.1(a) to (f), AS 4323.1. If the criteria in Clause 4.1(a) to (f), AS 4323.1 can be met approval for use of the non-compliant sampling plane must be sought in writing from the Authority before testing is undertaken.

If the velocity and temperature surveys conducted on ideal/satisfactory or non-ideal sampling planes do not meet all the criteria listed in Clause 4.1(a) to (f), AS 4323.1, the sampling plane is non-compliant.

Stacks not having the minimum number of access holes and tests performed without the minimum number of sampling traverses (Tables 3 and 4, AS 4323.1) are non-compliant.

If the sampling plane is found to be non-compliant an alternative sampling plane shall be sought.

If sampling planes are non-compliant and an alternative sampling plane cannot be found an alternative sampling strategy should be documented for approval by the Authority before testing is undertaken.

Gaseous Sampling

Obtaining a representative sample location for gaseous emission testing may be simpler than for particle/aerosol emission tests. A single sample point on the sampling traverse, at one quarter the diameter of the stack should be representative of the gaseous emission (refer to requirements in AS4323.1).

However, when velocity and volume flow rate are also to be determined the same criteria used for multi-point isokinetic sampling shall be met.

In a closed system, where the gas composition is homogeneous and unchanged, samples may be taken elsewhere in the system. Similarly, velocity and volume flow rate measurements may be taken elsewhere as long as the measurement position meets the same conditions used for particle/aerosol sampling.

APPENDIX B: QUALITY ASSURANCE SYSTEMS

The conduct and maintenance of quality systems ensures that the monitoring program and management decisions are supported by data of the type and quality required and expected for their intended use. Quality assurance procedures are mandatory for NATA accreditation.

For some compounds sampling and analytical procedures are well documented and the QA/QC systems are completely defined, and these should be followed. However, for many compounds the QA/QC systems are less well defined, and therefore method validation is required to improve confidence in the quantitative determination.

The following technical criteria should be met when untested methodologies are applied to emission testing.

The sampled species must be collected quantitatively.

If the temperatures in the sampling train are not high enough, some analytes may not reach the sampling media. Under these conditions the sample may not be quantitatively retained by the collection media. In most cases, the collecting media must be maintained at or below ambient temperatures to prevent sample break-through and to improve collection efficiency. Other problems may also occur, in conjunction with sampling, which prevent or interfere with quantitative sampling. Hence the importance of validation of the entire sampling and analysis system.

The laboratory sample preparation procedure must quantitatively transfer the sample from the sampling train to the analytical instrumentation.

Potential sample loss may result from:

- Non-quantitative extraction from the sampling media.
- Decomposition of the samples during handling or in the course of the analysis. (Some organic compounds may require derivatisation).
- Reaction with other species or reagents used in the sample preparation.
- Sample loss in a concentration step.

New methods must be fully validated for the test conditions for which they are to be used. The validation procedure must cover bias (systematic error) and precision (random error).

A typical protocol for validation would include:

- Introducing a known concentration of the analyte in the sampling procedure and carrying it through the entire sampling and analytical process to assess bias.
- Alternatively, the proposed test method may be compared with a previously validated method.

Multiple or simultaneous samples should be collected to determine the precision.

Sampling procedures for organic compounds have been established to allow the determination of bias and precision, these include:

- Isotopic spiking, for analysis requiring GC/MS.
- Comparison against a validated test method.
- Spiking of the organic compound

Users of sampling/analytical methodologies must:

- Perform some initial demonstration of capability and continue to conduct on-going demonstrations of capability.
- Maintain accurate and complete written records (chain of custody) and laboratory/sampling records for field measurements.
- Demonstrate that procedures are operating within control limits.
- Perform all quality control operations for instrumentation according to a scheduled program.
- Establish the ability to generate data of acceptable accuracy and precision.
- Locate and correct any instrument problems.
- Establish an appropriate scheme of blank determinations.
- When reporting data for which all quality criteria are not met, include qualifying comments in the report.
- Participate in external audits and performance evaluation studies.

Analysts should implement the following QC steps with each analytical batch.

Analysis blank - determination of the contribution to the analytical signal by reagents, glassware, etc. The contribution measured should be subtracted from the gross analytical signal for each analysis before calculation of sample analyte concentration.

Field blank - the sampling train is charged with reagents, assembled, transported to and from the sampling site and treated in exactly the same manner as the sample except it is not used for drawing sample from the discharge.

Replicate analysis - duplicate analysis of at least one sample from the batch.

Laboratory control sample - comprising a control matrix (such as deionised or tap water) or a replicate portion of a sample under analysis, fortified with analytes representative of the analyte class. Recovery check portions should be fortified at concentrations that are easily quantified, but within the range of concentrations expected for real samples.

Surrogate spikes - where appropriate (such as. chromatographic analysis of organics), surrogate spikes should be added to all analyses.

Surrogate spikes are known additions to each sample, blank and matrix spike or reference sample analysis, of compounds that are similar to the analytes of interest in terms of:

- extraction;
- recovery through clean-up procedures, and
- response to chromatographic or other determination; but which are not expected to be found in real samples;
- will not interfere with quantification of any analyte of interest; and
- may be separately and independently quantified.

Surrogate spikes are added to the analysis portion or to the sampling system containing the trapping media before extraction. The purpose of surrogates is to provide a means of checking, for every analysis, that no gross errors have occurred at any stage of the procedure leading to significant analyte losses.

In the case of organic analyses, the surrogate spike compounds may be deuterated, alkylated or halogenated analogues, or structural isomers of analyte compounds.

Internal standards -- use of internal standards is highly recommended for chromatographic analysis of organics. Internal standards are added, after all extraction, clean-up and concentration steps, to each final extract solution. The addition is a constant amount of one or more compounds with similar qualities to surrogate compounds.

The purpose of internal standards is to check the consistency of the analytical step (for example, injection volumes, instrument sensitivity and retention times for chromatographic systems) and provide a reference against which results may be adjusted in case of variation.

QC Records

Records of results of QC procedures should be maintained to provide a means of establishing method reliability, confidence intervals for analysis results, and trends in precision and accuracy. NATA accreditation requires that analytical methods and QA systems are regularly reviewed. However, no QA system is perfect and, as the user of the service, licence holders are entitled to question the analytical service regarding methods and QA procedures.

QA/QC Procedures for Emission Monitoring

Semi-continuous emission monitoring

Semi-continuous (batch) monitoring involves the transport of instrumental analysers to the monitoring site. Analysers are either operated at the sampling platform or located in a mobile laboratory. Sample gas is withdrawn from the discharge through a gas conditioning system to remove particulate matter, moisture, etc from the sample gas before presentation to the gas analyser. The conditioning system must not change the integrity of the sample gas. As the conditioning system and instrumental analysers are normally cold started, sufficient warm-up and conditioning time must be allowed before calibration and measurements are commenced.

Continuous emission monitoring

Continuous monitoring equipment for stack emission monitoring is normally attached to the stack and involves the equipment being located in harsh physical and chemical environments in areas not easily accessible. For these reasons it is important that a good quality assurance system is developed to ensure reliable, accurate data are produced and maintained.

For emission monitoring the following activities must be undertaken to achieve the required level of quality assurance and quality control. They apply for semi-continuous and continuous monitoring required by EPA for works approval or EPA licences.

Accreditation/Quality System

All monitoring must be conducted by a facility[1] accredited by NATA for sampling and testing in the field of stationary source emission testing. The accredited facility is required to establish and maintain a documented quality system that meets NATA requirements, Australian Standards, and other internal quality measures.

Staff

The accredited facility must ensure that training and supervision of staff is carried out by experienced, qualified personnel possessing appropriate tertiary qualifications in relevant disciplines. Staff must be trained to a sufficient standard to ensure they are capable of undertaking the relevant tasks in a competent manner.

The accredited facility must ensure that the training program consists of extensive ‘on the job’ instruction, in-house training programs and specialist training courses conducted by external organisations. Records of all training (including on-the-job training) received by staff and the level of skill attained must be maintained and such records must be available to EPA for inspection upon request.

Auditing

Internal audits must be conducted in accordance with a predetermined schedule and procedure that include all elements of the quality system over a 12-month period and an external auditor must be appointed to conduct an audit every 12 months. The audits must ensure that the operating procedures and equipment used to acquire emission monitoring data comply with NATA requirements and good laboratory practice. The results of these audits must be documented and all audit reports must be available for inspection by EPA upon request.

Monitoring Procedures

All measurements must be made, and instruments operated, in accordance with procedures in this guide.

Service and Maintenance

The accredited facility must ensure that all emission monitoring equipment produces high quality, accurate data and continuity of measurements by following a comprehensive and documented service and maintenance regime. All changes, such as adjustments or modifications to the equipment or systems, must be recorded, preferably in a dedicated logbook for each instrument. The records must clearly identify the person making the entry and the date on which the entry is made. A record of all instrument inspections must also be maintained.

Appropriate service schedules must be recorded for continuous emission monitoring equipment:

Daily

Each morning, competent, trained staff must examine the previous 24-hours’ data recovery to ensure that any malfunctions are discovered or allow prediction of instrument malfunction. Following demonstration of suitable instrument

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[1] In some circumstances, due to new monitoring technology or testing procedures, this may not be immediately achievable. In such cases, the licence holder should contact EPA and advise of the action that the non-accredited laboratory is taking to obtain accreditation. Accreditation must be obtained within six months of issue of the licence.

performance and reliability, daily checks may be relaxed to normal business days.

Weekly

Competent trained staff must:

- Perform a system check
- Ensure all instruments are currently calibrated and maintained
- Ensure all previously identified problems have been rectified and documented.

Monthly service

Each month, after a weekly service as described above is completed, competent trained staff must perform:

- Inspection of the entire system
- Copies of instrument documentation must be returned for use with data validation.

Six monthly service

This service must include all components of the monthly check. All major instruments, equipment and systems must be checked for correct operation and relevant components serviced according to the manufacturer's requirements.

The accredited facility must ensure that:

- The maintenance of equipment with servicing requirements greater than six months, has been performed; and,
- Service requirements recommended by instrument manufacturers are performed and critical service items are replaced.

Equipment or system malfunction

Any malfunctions, faults, data discrepancies or performance problems that are encountered must be registered, corrected and the correction documented. Any data produced by a faulty instrument, from the date of the last valid calibration until its return to service, must be recorded as invalid.

The accredited facility must ensure that:

- A record is kept of all instrument inspections.
- Repaired instruments undergo performance testing and are recalibrated prior to their return to service.
- Records of installation and removal of instruments are documented along with identification of the individual instruments (e.g. serial numbers).
- Logbooks assigned to individual instruments have sufficient detail to record all faults, repairs, adjustments, servicing and calibrations performed on the instrument. Logbooks must also record instrument movements and in-service operation periods.

Calibration

Calibrations must be scheduled and performed according to NATA and Australian Standards requirements as appropriate, good laboratory practice, and manufacturers' specifications. Performance testing and calibrations must also be performed after servicing, repairs or major breakdown.

Calibration procedures must be documented in the accredited facility's quality manual and clear and comprehensive calibration records must be maintained. Calibration standards must be certified and traceable to a primary calibration source. Only calibration standards with current certification may be used. Any discrepancies between the current calibration results and historical calibration results must be investigated and documented in the appropriate logbook.

The precision of continuous emission monitors used for long-term monitoring must be checked with independent reference methods. The frequency of independent reference method comparisons must be discussed with EPA.

Calibration of semi-continuous emission monitors

Prior to initial use, the gas analyser used for the monitoring of the analyte must be calibrated at 75% of full scale deflection (FSD) followed by a linearity check at 25% and 50% FSD, *i.e.* 3 point calibration plus zero. Six point calibration is required for non-linear instruments e.g. non-dispersive infra-red (15, 30, 45, 60, 75 and 90%). All FSDs are based on the operating range to be used. Linearity checks may be performed directly on the instrument and need not include the sampling inlet and conditioning systems. The maximum period between successive multi-point calibrations of the analyser must be six months.

A zero and span check on the entire sampling system is required immediately prior to the on-site test (within two hours of analyser stabilisation). A final zero and span check is required after site measurements have been completed. It is recommended that additional calibrations are performed at regular intervals throughout the day.

The single point span check should be made at 75-90% of full scale of the range in use or at a concentration close to the licence limit for the discharge under test. If the single point span check is greater than 10% of the analyser's previous calibration value then a full multi-point calibration must be performed.

The NATA accredited facility must ensure that:

- Calibration is not commenced until the instrument has sufficiently warmed up and stabilised. This may be hours for some analysers. (Refer to the manufacturer’s instructions).
- Calibration of the measurement system includes the entire sampling and analysis unit including all gas conditioning equipment (e.g. probe, sample line, filtration, water removal etc.).
- The analyser is calibrated on the same range, at the sample gas flow rate, pressure, temperature and operating procedure used to monitor the gas stream.
- Zero and span gas flow rates to the analyser are greater than the instrument flow demand, to prevent drawing in ambient air (but not too high to cause back pressure on the analyser). A ‘T’ piece or dump valve should be used.
- Sample line gas conditioning losses are checked. A check may be performed by introducing calibration gas through the entire sampling and analysis system. The calibration gas is then presented directly to the analyser. The difference between measurements indicates the sample loss for the sampling and analysis system.

- The capacity of the sample-conditioning unit is not exceeded.
- For sampling systems that do not remove moisture, the temperature of the sample gas is maintained above the dewpoint. (Results for these systems will give 'wet' concentration of pollutant. The pollutant concentration is usually expressed as 'dry' gas).
- Zero air is dry, filtered to remove particles and free of the contaminant being measured.
- Span mixtures (calibration gas standards) are chemically stable, free of contaminants and certified and traceable to a primary calibration source.

Data validation

The accredited facility must ensure that the data are examined and validated so that they have been adjusted to account for calibration and instrument adjustments. Any data produced during equipment malfunction or fault must be clearly identified and declared invalid. Sources of error may include data logger malfunction, transmission errors, calculation errors and errors in reporting.

Records and reporting

All logbooks, individual instrument logbooks, validation calculations, work sheets, alterations and calibration data must be checked by a second person and signed by the person making the original calculation and the checker. These records must be archived for a minimum of three years.

The accredited facility must notify EPA immediately in writing if information becomes available that casts doubt on the accuracy or correctness of any report, data or other information supplied to EPA.

Reports to be verified

The accredited facility must nominate a person who is a director, or concerned in the management of the licence holder, to verify the truth or correctness of any air monitoring reports or documentation supplied to EPA under a works approval/licence.

All air monitoring documents supplied under a works approval/licence to EPA must be signed by the above-nominated person.

QA/QC procedures for ambient air monitoring

The QA/QC procedures for ambient air monitoring are the same as those listed for emission monitoring, except for the following specific requirements.

Monitoring procedures

All measurements must be made, and instruments operated, in accordance with the procedures specified in EPA approved methods for ambient air measurements.

Other monitoring methods may be used if:

- Calibration and validation studies show the accuracy and precision of the other method can be compared with the relevant Australian Standard method.
- The equipment used is calibrated to the standard required by the equipment manufacturer; and
- The equipment provides equivalent information for assessment purposes.

Service and maintenance

The accredited facility must ensure that all air quality monitoring instruments and related ancillary equipment produce high quality, accurate data and continuity of measurements by following a comprehensive and documented service and maintenance regime. The accredited facility must record, in a dedicated logbook (or equivalent) for each instrument, all changes, adjustments or modifications to the equipment or systems. The records must clearly identify the person making the entry and the date on which the entry is made. A record of all instrument inspections, movements, adjustments and service work must also be maintained.

The following service schedules must be used:

Daily

Each morning, competent, trained staff must examine overnight calibration results and assess the previous 24-hours data recovery to ensure that any malfunctions are discovered or allow prediction of station system or instrument malfunction. Following demonstration of suitable instrument performance and reliability, daily checks may be relaxed to normal business days.

Fortnightly

Competent trained staff must attend each station to perform documented servicing of station systems. This is a preventative measure aimed at forestalling serious problems that may not be discovered during the daily check. This must include:

- Changing gas analyser sample filters (longer service life of filters may be permitted if on-site trials demonstrate that monitoring results are not affected).
- Recording analyser gain adjustments or any other instrument changes.
- Ensuring standard reference materials (e.g. gases) have current certificates of analysis.
- Ensuring all instruments are currently calibrated.
- Visual condition and performance assessment of meteorological sensors (if applicable).
- Confirmation of primary sample manifold flows and gas analyser sample flows.
- Ensure all previously identified problems have been rectified and documented.

Monthly service

Each month, after a fortnightly service as described above is completed, competent trained staff must perform a major service of the station.

The monthly service must include:

- Replenishing consumables (check sufficient calibration gas reserves for coming month).
- Cleaning or replacing sample lines, confirming correct solenoid operation, and ensuring all sample line joints are leak proof.
- Checking and correcting all pressure and vacuum settings.
- Checking of records for transcription errors.
- Returning copies of station and instrument documentation along with chart records (if applicable) for use with data validation.

Six monthly service

This service must include all components of the monthly check. All major instruments, equipment and systems must be checked for correct operation and relevant components serviced according to the appropriate Australian Standard or manufacturer's requirements.

The accredited facility must ensure that:

- The maintenance of equipment with servicing requirements greater than six months has been performed (e.g. zero air catalytic oxidiser servicing).
- Service requirements recommended by instrument manufacturers are performed and critical service items are replaced.

Equipment or system malfunction

Any malfunctions, faults, data discrepancies or performance problems that are encountered must be registered, corrected and the correction documented. Any data produced by a faulty instrument, from the date of the last valid calibration until its return to service, must be recorded as invalid.

The accredited facility must ensure that:

- Manual particle samplers operate for 24-hour run periods (calendar day) and run times other than 24±1 hours are declared invalid.
- Particle samplers and size selective inlets are checked for damage (e.g. cracks, deformation *etc.*), leaks, and the flow control and timing devices are checked to ensure proper functioning.
- Routine site visits are made to ensure particle sampling equipment is operating on the prescribed day, if operating on other than a daily sampling sequence.
- A record is kept of all instrument inspections.

The accredited facility must ensure that:

- Repaired instruments are performance tested and recalibrated prior to their return to service.
- Records of installation and removal of instruments are documented along with identification of the individual instruments (e.g. serial numbers).
- Logbooks (or equivalent) assigned to individual instruments have sufficient detail to record all faults, repairs, adjustments, servicing and calibrations performed on the instrument. They must also record instrument movements and in-service operation periods.

APPENDIX C: GUIDELINES FOR USE OF AS 4323.3 DETERMINATION OF ODOUR CONCENTRATION BY DYNAMIC OLFACTOMETRY

Sampling and analysis for odour from licensed premises must be undertaken in accordance with the EPA-approved procedure, Australian Standard 4323.3.

The following list of guidelines are requirements of EPA Victoria for users of AS 4323.3 for licence monitoring of odour emissions.

Panel

Panel members must be screened with n-butanol prior to environmental samples and results used to update the panel member's odour threshold history (clause 9.7.2, AS4323.3).

The panel size must start with a minimum of six panel members and after retrospective screening results from no less than four panel members may be used to calculate the panel threshold (clause 9.7.3, AS4323.3).

If during an assessment, a panel member produces two certain but incorrect responses, then that panel member's results must be excluded from the calculation of the result of that measurement.

Detection mode:

The recommended detection mode for odour threshold measurements is forced-choice (clause 11.1.3, AS4323.3).

Number and order of presentations

The presentation of sample must be in ascending order with a minimum number of five presentations (clause 11.3.1, AS4323.3).

Difference between subsequent concentrations (Step factor)

The recommended dilution series step factor is 2 (clause 11.4, AS4323.3).

Number of rounds to determine a panel threshold

The number of valid rounds in a measurement must be at least two. A preliminary round of a measurement must be made and the data excluded to leave data from the next two rounds on which to base the calculation. (clause 11.5, AS4323.3). For duplicate samples assessed at the same time using the same panellists the preliminary round for the second sample may be omitted.

Sampling procedures

A minimum of two samples must be collected for a constant emission source. Additional samples must be collected if emissions are variable (clause 10.4.3, AS4323.3).

Minimum information recording requirements

The precision of odour measurements must be included in the final NATA endorsed test report (Appendix E, AS4323.3).

The panel threshold value must be included in the final report (clause 12.3.1, AS4323.3).

The time interval between sampling and analysis must be included in the final report (clause 12.1, AS4323.3).

Minimum information for archiving concerning an odour concentration measurement

The material used for sample containers must be recorded (clause 9.3, AS4323.3).

The panel operator must document that neutral gas has been tested by panel members prior to measurement (clause 12.3.3, AS4323.3).

APPENDIX D: SUMMARY OF PERFORMANCE MONITORING - AIR EMISSIONS

Licence Holder

Address

Contact

Phone

EPA Licence Number

Results submitted to satisfy licence requirement for monitoring period _________ to__________

Laboratory name

NATA registered for these tests? Y• N•

Contact

I signify that this is an accurate summary of the performance monitoring results obtained.

Signed

Position

Date

Discharge point No.	Component	Date of test	Rate (g/min)		Concentration (mg/m^3)*			Comments
			Measured	Licence limit	Measured	Licence limit	Corrected to**	

*concentrations expressed as dry at 0°C, 101.3kPa unless otherwise noted

***e.g.* 7% O_2, 12% CO_2

APPENDIX E: COMMUNITY AIR MONITORING

This appendix is provided for individuals or groups who seek to undertake air quality monitoring in their local community but do not have the resources to purchase and operate approved air pollution analysers.

The aim is to offer limited alternative methods that can be used to provide a basic assessment of some common air pollutants. These methods have limitations and should be considered as screening techniques for identifying air pollution hot spots. Monitoring results from alternative methods may not give comparable results to EPA approved methods. It is recommended that EPA be consulted about the suitability of alternative methods prior to conducting a monitoring program. In the event a screening method identifies pollutant levels of concern (values at or above intervention levels) an approved method should be used to verify air quality.

Some alternative methods can provide real-time air monitoring results; however, most are low cost sampling devices that involve sample collection then shipment to an analytical laboratory for analysis. Although the initial cost of the sample collection medium may be low, significant analytical costs are usually associated with the analysis of the collected pollutant.

Gases

Passive samplers

Passive (diffusion) samplers are useful for determining gas concentrations where accumulated environmental exposure rather than short time resolution is required. The small low cost device is typically exposed in the field for one week and returned to an analytical laboratory for analysis. Passive samplers have been developed for the assessment of some gases (e.g. SO_2, NO_2, formaldehyde etc.). The devices can be easily located in the field under a simple rain shelter and do not require sample pumps or power.

Electrochemical analysers

These analysers are usually located where high concentrations of pollutants might be expected as they lack the sensitivity for measuring typical ambient pollutant levels. The analysers are portable and are best suited for surveys rather than continuous monitoring. The target gas permeates through a membrane and causes an oxidation-reduction reaction that causes a change in the electrical output of the cell. Commercial units are available to measure CO, H_2S, SO_2 and NOx. The analysers require routine calibration with certified gas. The sensors can be prone to cross-sensitivities and have a limited life.

Volatile organic compounds. Canister sampling

This method is capable of determining low levels (sub-ppm) of ambient VOCs. Ambient samples are drawn into specially prepared inert canisters. Samples are analysed in a laboratory by focussing sampled VOCs on a cryogenic trap followed by GC/MS analysis techniques. The canisters can be easily deployed for field use, as they do not require an environmental shelter or power.

Volatile organic compounds. Solid adsorbent - Suitable adsorbents can be used for trapping VOC. The sample collected on the adsorbent trap is best analysed by thermal desorption of the trapped VOCs on to a GC system. Sample collection may require the use of a sample pump and flow controller, therefore a sample enclosure and power are required.

Particles

Nephelometry - light scattering techniques - continuous monitoring.

Portable instruments are available that monitor light scattering properties of particles that can be related to mass concentration. The instruments are portable and can be used for surveys or they can be placed in an environmental shelter for longer-term monitoring. The instrument is best calibrated against a manual particle sampling method in a similar environment to where the instrument is to be used.

Portable low flow samplers – manual gravimetric

Low volume samplers can be used to collect information on suspended particles (total suspended particles (TSP), PM10 or PM2.5) in the atmosphere. The sampler can be fitted with different size selective inlets to allow collection of different particle size ranges onto pre-weighed filter media. The small sample volumes generally require the use of microbalances for gravimetric measurements. Some samplers can operate from battery or solar panels and are usually small enough to be easily sited.

Dustfall - deposition gauges - manual gravimetric

This technique has found application in areas where nuisance dust (coarse particles) is a problem. Particles settling from the atmosphere are collected via a funnel into a container (AS 3580.10.1). After a suitable exposure period (typically one month) the collected sample is returned to the laboratory for analysis. The method does not measure TSP, and if the objective is to measure TSP or particle fractions implicated in health effects then other methods that involve active sampling with size selective inlets should be used.