MANAGING EMISSIONS OF VOLATILE ORGANIC COMPOUNDS

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INTRODUCTION

Many industrial and commercial activities emit wastes to air that must be minimised and controlled to protect the environment. Emissions to air must be managed in accordance with the provisions of the *State Environment Protection Policy (Air Quality Management)* [SEPP (AQM)], which include waste minimisation, best practice, and continuous improvement.

A wide range of volatile organic compounds (VOCs) are emitted to air from activities such as combustion processes, manufacturing industries and other industries using organic based solvents. Some of these emissions are mixtures of many volatile organic compounds, making it difficult to identify all the individual compounds in the mixture.

Generators of VOCs should characterise their emissions to enable better management of those emissions so that they ensure protection of the beneficial uses of the environment. This information bulletin is to assist VOC generators in this process and is divided into the following sections:

1. Definition of volatile organic compounds (VOCs).
2. The potential environmental impacts of VOCs at local, regional and global levels.
3. Characterising and managing VOC emissions.

Generators of VOC emissions are encouraged to consult with EPA Victoria during the early stages of the characterisation. VOC emissions may need to be re-characterised following any changes to the activities at the site that may lead to changes in emissions.

1. VOLATILE ORGANIC COMPOUNDS

Most organic compounds listed as Class 2 and 3 indicators in Schedule A of the SEPP (AQM) fall within the definition of a volatile organic compound.

Some of these compounds may currently be described in EPA licences by one of several terms, including: total organic compounds (TOC), volatile organic compounds (VOC), hydrocarbons (HC), non-methane hydrocarbons (NMHC), non-methane organic compounds (NMOC), non-methane volatile organic compounds (NMVOC), total hydrocarbons (THC), and reactive organic gases (ROG).

Volatile organic compound (VOC) means any chemical compound based on carbon with a vapour pressure of at least 0.01kPa 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 carbon monoxide (CO), carbon dioxide (CO_2), carbonic acid, metallic carbides and carbonate salts.

Future EPA licences will use the term unspecified VOC when referring to a mixture of compounds that meets the definition of VOC given in this information

bulletin and where the individual compounds do not warrant individual attention.

In some cases it is important that the presence of individual class 2 and class 3 indicators in the mixture be identified, as options for the management of these emissions may differ. In addition, VOCs that are not currently listed as class 2 or 3 indicators may need to be separately identified if present in significant quantities.

Class 2 indicators are defined in SEPP (AQM) as hazardous substances that may threaten the beneficial uses of the air environment by virtue of their toxicity, bio-accumulation or odour characteristics.

Class 3 indicators are defined in SEPP (AQM) as extremely hazardous substances that are carcinogenic, mutagenic, teratogenic, highly toxic or highly persistent, and which may threaten the beneficial uses of the air environment.

2. POTENTIAL ENVIRONMENTAL IMPACTS OF VOCs

Emissions of VOCs may have adverse environmental impacts on the local, regional and global atmosphere.

Local Impacts

a. Toxicity

VOCs that include Class 2 and Class 3 indicators have known toxic properties and must be controlled so that the likely concentrations at a local level do not cause adverse impacts.

b. Odour

Many VOCs are odorous, and even in small quantities may adversely affect amenity at a local level. A number of class 2 indicators have been identified as being odorous, however, many odours arise from complex mixtures consisting of a very large number of unidentified compounds.

Regional Impacts

VOCs are major contributors to the formation of photochemical smog. During summertime, smog is formed by photochemical reactions between volatile organic compounds, sunlight and oxides of nitrogen to form ozone. VOCs have varying potential to participate in photochemical smog formation.

The Port Phillip air emissions inventory maintained by EPA shows that industrial premises contribute about 15 per cent of the total VOCs in the Melbourne airshed. This compares to about 29 per cent from motor vehicles, 28 per cent from domestic, commercial and rural sources and 27 per cent from natural sources.

Global Impacts

VOCs may act directly or indirectly (following dissociation into water and carbon dioxide) as greenhouse gases. Some VOCs may be ozone-depleting compounds and so contribute to the depletion of the ozone layer.

3. CHARACTERISING AND MANAGING VOCS

SEPP (AQM) requires that emissions of wastes to air be managed in accordance with the principles of the wastes hierarchy. In addition, best practice must be

applied to all stages of a process that may lead to the emissions of waste. For class 3 indicators, emissions to air must be reduced to the maximum extent achievable (MEA).

Further information on managing emissions to air in general are given in EPA publications 843 *The New SEPP (AQM) – Information for all EPA Licence Holders* May 2002 and 844 *The New SEPP (AQM) – Achieving Compliance* May 2002.

The wastes hierarchy gives the order in which wastes must be managed - avoid, re-use, recycle, recover energy, treat, contain, dispose.

Best practice means the best combination of eco-efficient techniques, methods, processes or technology used in an industry sector or activity that demonstrably minimises the environmental impact of a generator of emissions in that industry sector or activity.

Maximum extent achievable (MEA) means a degree of reduction in the emission of wastes from a particular source that uses the most effective, practicable means to minimise the risk to human health from those emissions and is at least equivalent to or greater than that which can be achieved through the application of best practice.

It is the responsibility of a generator of emissions to minimise emissions that may have the potential to have an adverse impact on the beneficial uses of the environment. Where mixtures of organic compounds are emitted, individual compounds may be present in the mixture that pose a significant risk or loss of amenity due to their toxicity, odorous properties or quantity of emissions.

Generators of emissions of VOCs are required to identify the individual compounds that are likely to be in their VOCs to assist them in assessing the environmental impacts and to assist them in prioritising actions for environmental improvement. For example, the identification of the more hazardous compounds will enable these compounds to be targeted for substitution or higher levels of control.

The following steps set out the characterisation and subsequent management process.

Step 1. Identification of individual compounds of interest.

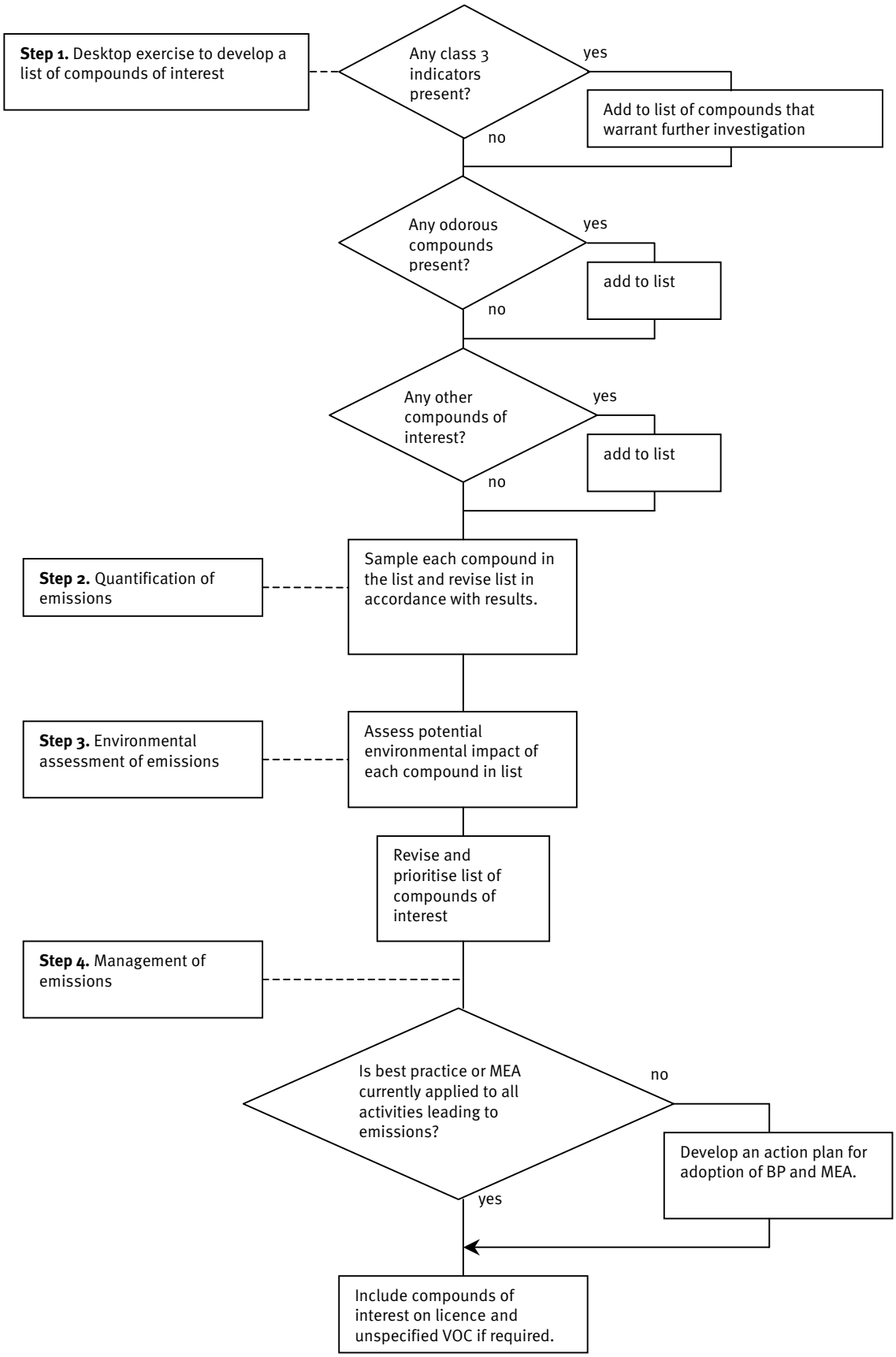
Step 2. Quantification of emissions of interest.

Step 3. Environmental assessment of emissions of interest.

Step 4. Management of emissions

These steps will assist both operators of existing sites to improve their management of VOCs, and proponents of new facilities to minimise emissions and demonstrate that the beneficial uses of the environment are protected. Existing EPA licence holders are advised to discuss the issues with EPA to ensure that the appropriate steps are taken.

Figure 1. Characterisation and management processes for VOC emissions



Step 1. Identification of individual compounds in the mixture

In step 1, generators of VOC emissions should compile a list of individual compounds in their emissions that warrant further investigation. A desktop exercise should be conducted to identify the individual compounds before undertaking any actual sampling. In many cases it is not possible or necessary to identify all the compounds in a mixture.

Step 1a. Identify all class 3 indicators that are expected to be present in the emissions and list for further investigation.

Step 1b. Identify all odorous compounds such as mercaptans and acrylates that are expected to be present in the emissions and list for further investigation.

Step 1c. Identify any remaining VOCs that may pose an individual environmental risk. The potential risks to the environment associated with any remaining VOCs need to be examined to determine the approximate level of emission where further investigation is required.

Some compounds may present a risk to the environment even in very small quantities. The numerical value of the relevant design criterion may be used as a guide to show the relative impact when compared to other compounds in the mixture.

Other compounds may only present a risk if they are emitted in large quantities. All compounds that make up a significant proportion of the total discharge need to be identified. As a guide, where compounds comprise more than approximately 1 per cent of the total VOC emission (by weight) up to 10 individual compounds should be considered.

Step 1d. Once all individual compounds of interest have been identified, any remaining VOC emissions should be managed as unspecified VOC.

Techniques for identifying individual compounds

A number of different desktop techniques are available to assist in the identification of individual compounds in a mixture. The techniques depend on the source of the emissions.

Combustion processes

For many combustion sources such as gas-fired boilers it is not necessary to identify individual compounds. For more complex combustion processes that may lead to VOC emissions of concern, these emissions should be investigated. In the first instance reference should be made to any information relating to the likely compounds in the mixture, depending on the combustion conditions and the fuel or wastes consumed. This information may be available from the suppliers of the combustion equipment and the fuels used or from similar operations here or overseas.

Other sources of VOC emissions

For solvent-based processes in which there are no chemical transformations of VOCs, the supplier may be consulted as to the compounds in the mixture and the emissions determined from a mass balance calculation.

In situations where chemical transformation occurs, engineering calculations or emission factors may be used to determine the likely reaction products. The National Pollutant Inventory provides a wide range

of industry handbooks that give guidance on emission estimation techniques. These are available from the NPI website at www.npi.gov.au/handbooks

Step 2. Quantification of emissions.

Once a list of individual compounds that warrant further investigation has been developed, emissions of these compounds should be sampled and analysed in accordance with the latest version of EPA publication 440.1 *A Guide to the Sampling and Analysis of Air Emissions* available on our website at www.epa.vic.gov.au.

In accordance with the list developed in Step 1, the following sampling and analysis should be undertaken:

Step 2a. Any class 3 indicators;

Step 2b. Any odorous compounds, such as mercaptans and acrylates;

Note: If general odour from a complex mixture of unidentified VOCs is a potential or existing problem at a site, the concentration of odour from the emissions (in odour units) may be measured using the EPA approved odour measurement method to assist in identifying and managing sources of odour.

Odour testing involves very large dilution of samples, typically greater than 1000 times. Class 3 indicators already at trace levels will be diluted further (say 1000 times) and should not pose any health risk to panellists at these very low levels, however, odour samples should not be taken from discharge points where the VOC emissions are known or suspected to contain class 3 indicators.

Step 2c. Any other individual compounds identified in Step 1c; and

Step 2d. Unspecified VOC expressed as an equivalent concentration to the major component of the mixture.

Example

A company has sampled emissions from a discharge point and measured and reported the discharge as 10g/m^3 hexane equivalent concentration in line with previous EPA requirements.

Characterisation of the same emissions in accordance with this information bulletin identifies a small quantity of benzene (a class 3 indicator), with the mixture consisting mainly of toluene (~70%) and xylene (~10%) (class 2 indicators). Other individual compounds in the mixture that may warrant further investigation are identified in accordance with Step 1c. These identified compounds are separately quantified and reported in accordance with EPA publication 440.1 *A Guide to the Sampling and Analysis of Air Emissions*. The unspecified VOC is reported as toluene equivalent concentration.

Step 3. Environmental assessment of emissions.

Following completion of Steps 1 and 2, the potential environmental impacts must be assessed.

Local impacts

Assessment against design criteria is generally only required for the design of a new or expanded source of emissions, and is undertaken once the design meets SEPP (AQM) requirements for best practice or MEA. Since the individual compounds in VOC emissions from existing sites may not have been

previously assessed, it is appropriate to use emissions modelling and design criteria as indicators of the potential impact of the emission.

Individual compounds of interest identified in steps 1a, 1b, and 1c should be modelled in accordance with SEPP (AQM) Schedule C - Modelling Emissions to Air. The predicted maximum concentration should be compared to the relevant design criteria in SEPP (AQM) Schedule A for class 2 and class 3 indicators. For any compounds not listed in Schedule A, EPA should be consulted for the appropriate design criteria.

The potential impact of the emission based on the modelling results will assist in prioritising actions for reducing emissions.

The emission rate of any unspecified VOC should be reported to EPA. In most cases no further assessment will be required, however depending on the nature and quantity of the unspecified VOC, EPA may require additional assessment.

Regional impacts

Assessment of regional impacts is generally only relevant for large sources (more than 100 tonnes per year). In these cases, consideration should be given to the photochemical reactivity of alternative solvents, provided that the toxicity or odorous impacts of the emissions are not increased.

The total maximum daily amount of VOC discharged from a facility may be used to assess regional impacts. There are a number of sources of information on the regional impacts associated with VOCs including, the Council of the European Union directive[1], Californian regulations[2] and the National Pollutant Inventory. Information on VOC emissions is available at the NPI website at www.npi.gov.au

Global impacts

All EPA licence holders are required to report on their greenhouse gas emissions under SEPP (AQM). The report should include comments on any greenhouse emissions that may result from emissions of VOCs.

Any site with emissions of VOCs that are ozone depleting must comply with *Industrial waste management policy (Protection of the Ozone Layer)*. Further details are available at www.epa.vic.gov.au

In line with the principle of integrated environmental management, it is useful to compare the local, regional and global impacts of VOC emissions to achieve the most favourable overall environmental outcome.

Step 4. Management of emissions.

SEPP (AQM) requires that the wastes hierarchy, best practice (or MEA for Class 3 indicators) be applied to the management of all emissions to air. For the individual compounds identified in Steps 1 and 2, all activities leading to these emissions must be reviewed and assessed in this context.

For existing sites where best practice (or MEA) is not currently applied, an action plan should be developed setting out how best practice (or MEA)

[1] Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and industries.

[2] Title 17, State of California Code of Regulations, Article 3, Aerosol Coating Products, Sections 94521-94524 and 94526, "Reducing Volatile Organic Compound Emissions from Aerosol Coating Products" URL address: www.arb.ca.gov/regact/conspro/aerocoat/finreg.doc

will be achieved at the site. Where possible, the action plan should be integrated into any existing environment improvement plan (EIP) for the site. The assessment undertaken in Step 3 will assist in prioritising actions that will lead to emissions reductions. Step 3 should be repeated using estimates of the expected reduction in emissions once best practice or MEA is adopted.

If the assessment indicates that there may still be an adverse environmental impact even after best practice (or MEA) has been adopted, it may be necessary to install additional emission control equipment. Control equipment must be selected based on best practice (or MEA) and on greenhouse and energy considerations.

Best practice must be applied to the management of general odour in the same way as it is for any other emissions to air. Any odour measurement or odour emission estimation carried out as part of Step 2 can be used in dispersion modelling to predict the odour off-site. This should then be used in a risk assessment of the local impact on amenity that takes into consideration the proximity of sensitive uses, the frequency and the concentration of the odour.

In future EPA licences will include an emission limit for individual volatile organic compounds that warrant individual attention in accordance with these guidelines. Compounds that are emitted in quantities unlikely to have an adverse impact on the environment will not be separately listed on the EPA licence. EPA will use the term unspecified VOC as the collective term for emissions of volatile organic compounds that have not been individually specified.

Applications for works approvals and licence amendments must demonstrate that best practice (or MEA) has been applied as required by SEPP (AQM) and sufficient information provided regarding emissions and predicted ground level concentrations.

All industrial and commercial premises are encouraged to develop an EIP that provides a framework for continuous improvement of their environmental performance. The EPA publication (number 739) *Guidelines for the Preparation of Environment Improvement Plans* will assist in the development of such plans.