National Environment Protection (Air Toxics) Measure

Air Toxics Tier 2 Prioritisation Methodology

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CONTENTS

ACRONYMS

ATSDR	Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services
COPD	Chronic Obstructive Pulmonary Disease
EPHC	Environment Protection and Heritage Council
IARC	International Agency into Research into Cancer
IPCS	International Programme on Chemical Safety
IRIS	US EPA Integrated Risk Information System
MRL	Minimal Risk Level
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NPI	National Pollutant Inventory
OEHHA	Office for Environmental Health Hazard Assessment, Californian Environmental Protection Agency
PAH	Polycyclic Aromatic Hydrocarbon
REL	Reference Exposure Level, developed by OEHHA
RfC	The inhalation Reference Concentration, developed by USEPA
URF	Unit Risk Factor for carcinogens
US EPA PBT list	US EPAs priority list of persistent, bioaccumulative and toxic chemicals
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WHO	World Health Organisation

GLOSSARY

Aggregate emission sources	Diffuse emissions from sources other than NPI reporting facilities. Includes: (a) Small to medium commercial and industrial enterprises and facilities not required to report to NPI because emissions are below the reporting threshold; and (b) Mobile and domestic sources such as motor vehicles, domestic wood heaters, domestic lawn mowing.
Emissions Factor	A representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant.
Facility	Any building or land from which a substance may be emitted, together with any machinery, plant, appliance, equipment, implement, tool or other item used in connection with any activity carried out at the facility; and includes an offshore facility.
NPI reporting facility	A facility that is required to report information under clause 9 of the (Australian) National Environment Protection Measure for the National Pollutant Inventory.
Monitoring Investigation Level	The concentration of an air toxic which if exceeded requires an appropriate form of further investigation and evaluation.
VKT data	Vehicle kilometres travelled by various categories of vehicles. Generally used to estimate air pollution emissions from fuel combustion.

1. INTRODUCTION

In December 2004 the National Environment Protection Council (NEPC) made the National Environment Protection Air Toxics Measure (Air Toxics NEPM). The Air Toxics NEPM provides a nationally consistent framework for the monitoring and reporting of five air toxics – benzene, formaldehyde, toluene, xylenes and PAHs (as benzo-a-pyrene). It also includes monitoring investigation levels for these pollutants to assist in the interpretation of the monitoring data.

When the Air Toxics NEPM was initially being scoped, it was agreed that a phased approach would be adopted to develop the NEPM where hazardous pollutants not included in the original NEPM could be incorporated at a later date. Council agreed to establish a working group to develop a methodology to prioritise additional pollutants to be considered for inclusion in the NEPM.

The working group was established under the EPHC Air Quality Working Group. The main task of the working group was to develop and trial a prioritisation methodology to rank and screen pollutants. The purpose of the methodology is to identify priority pollutants in ambient air that are of national significance in terms of exposure and that may pose a risk to human health. The emphasis of the health risk is on public health rather than occupational health. The priority pollutants identified may then be considered for incorporation in the NEPM, and standards or guidelines may be developed for them. The prioritisation also provides individual jurisdictions with information on priority pollutants in their jurisdictions that may in turn guide the development of air quality management strategies.

A risk-based methodology to prioritise pollutants has been developed. The prioritisation system comprises two components: hazard identification and exposure estimation. In applying the methodology, pollutants are first ranked separately on the basis of hazard and exposure. Each component is then combined to give the final relative risk ranking. In developing the methodology, reviews of international approaches were undertaken and the resulting methodology draws upon these international approaches.

The methodology was trialled using substances in the National Pollutant Inventory (NPI) as a starting list of pollutants. The NPI is a national and jurisdictional database providing information on the sources, types and amount of substances emitted to air. At the time of the trial the NPI contained data on 90 substances, which have been identified as important because of their possible health and environmental effects.

This report: sets out the detailed methodology; provides the justification for the issues included; details the hierarchy of data sources to be used in the application of the methodology; includes the outcomes of the trial using NPI data; and makes recommendations for the application of the methodology to develop a list of priority pollutants to be considered for inclusion in the Air Toxics NEPM.

2. METHODOLOGY FOR PRIORITISATION OF AIR TOXICS

The components of the methodology and their respective scores are shown below. The methodology contains questions that relate to both health effects (hazard) and environmental effects (exposure). Combining the scores for each component provides a method for ranking pollutants based on the potential risk posed to the Australian population.

Hazard identification

a) Cancer effects
b) Reproductive, developmental or mutagenic effects
c) Respiratory effects
d) Chronic non-cancer effects
e) Substance known to affect multiple systems
f) Bio-accumulation
g) Other, or emerging, health effects

Exposure considerations

a) NPI emissions
b) Multiple sources
c) Persistence in the atmosphere
d) Photochemical smog forming potential

2.1 HAZARD IDENTIFICATION

a) Cancer effects

(i) IARC/U.S. EPA cancer classification

IARC Group 1 or U.S. EPA Group A	20
IARC Group 2A or U.S. EPA Group B1	10
IARC Group 2B or U.S. EPA Group B2	5
IARC Group 3 or U.S. EPA Group C	1
IARC Group 4 or U.S. EPA Group D	0

(ii) Unit risk factor $(\mu g/m^3)^{-1}$

Unit risk factor $\geq 10^{-2}$	6
Unit risk factor $\geq 10^{-3} < 10^{-2}$	5
Unit risk factor $\geq 10^{-4} < 10^{-3}$	4
Unit risk factor $\geq 10^{-5} < 10^{-4}$	3
Unit risk factor $\geq 10^{-6} < 10^{-5}$	2
Unit risk factor $\geq 10^{-7} < 10^{-6}$	1
Unit risk factor $< 10^{-7}$ or no unit risk factor	0

b) Reproductive or developmental or mutagenic effects

Demonstrated reproductive or developmental or mutagenic effects in humans	10
Demonstrated reproductive or developmental or mutagenic effects in animals	5
Possible reproductive or developmental or mutagenic effects in humans or animals	2.5
No demonstrated reproductive or developmental or mutagenic effects	0

c) Respiratory effects

Known to cause asthma, sensitisation, or other chronic lung diseases	5
Exacerbates asthma or existing respiratory conditions	3
Known to cause irritation of the airways	1
No demonstrated respiratory effects	0

d) Chronic non-cancer effects

Air quality guidelines ($\mu g/m^3$) for chronic non-cancer inhalation exposure

Guideline < 10^{-4}	10
Guideline ≥ 10^{-4} < 10^{-3}	9
Guideline ≥ 10^{-3} < 10^{-2}	8
Guideline ≥ 10^{-2} < 10^{-1}	7
Guideline ≥ 10^{-1} < 10^{0}	6
Guideline ≥ 10^{0} < 10^{1}	5
Guideline ≥ 10^{1} < 10^{2}	4
Guideline ≥ 10^{2} < 10^{3}	3
Guideline ≥ 10^{3} < 10^{4}	2
Guideline ≥ 10^{4} < 10^{5}	1
Guideline ≥ 10^{5} or no Guideline	0

e) Substance known to affect multiple systems

Substance affects 4 or more organs/systems	4
Substance affects 3 organs/systems	3
Substance affects 2 organs/systems	2
Substance affects 1 organ/system	1
No organs/systems affected	0

f) Bio-accumulation

Demonstrated bio-accumulation in humans	3
Demonstrated bio-accumulation in animals	2
Uncertain or no data	1
No bioaccumulation demonstrated	0

g) Other, or emerging, health effects

Yes	2
No	0

Total Hazard Identification (THI) Score = 1ai + 1aii + 1b + 1c + 1d + 1e + 1f + 1g

2.2 EXPOSURE CONSIDERATIONS

a) NPI emissions (tonnes/year)

NPI emissions ≥ 100,000	10
NPI emissions ≥ 50,000 < 100,000	9
NPI emissions ≥ 10,000 < 50,000	8
NPI emissions ≥ 5,000 < 10,000	7
NPI emissions ≥ 1,000 < 5,000	6
NPI emissions ≥ 500 < 1,000	5
NPI emissions ≥ 100 < 500	4
NPI emissions ≥ 50 < 100	3
NPI emissions ≥ 10 < 50	2
NPI emissions ≥ 1 < 10	1
NPI emissions < 1 or no data	0

b) Multiple sources (% of total emissions from aggregate sources)

Multiple sources, of regional concern, aggregate Emissions ≥ 90	10
Multiple sources, of regional concern, aggregate Emissions ≥ 80 < 90	9
Multiple sources, of regional concern, aggregate Emissions ≥ 70 < 80	8
Multiple sources, of regional concern, aggregate Emissions ≥ 60 < 70	7
Multiple sources, of regional concern, aggregate Emissions ≥ 50 < 60	6
Multiple sources, of regional concern, aggregate Emissions ≥ 40 < 50	5
Multiple sources, of regional concern, aggregate Emissions ≥ 30 < 40	4
Multiple sources, of regional concern, aggregate Emissions ≥ 20 < 30	3
Multiple sources, of regional concern, aggregate Emissions ≥ 10 < 20	2
Multiple sources, of regional concern, aggregate Emissions < 10 or no data	1

c) Persistence in the atmosphere

≥ 40 days	5
≥ 4 < 40 days	4
≥ 0.42 < 4 days (10 hours to 4 days)	3
≥ 0.042 < 0.42 days (1 to 10 hours)	2
< 0.042 days (1 hour)	1

d) Photochemical smog forming potential

Relative photochemical reactivity of substance	
> 0.75	4
> 0.5 ≤ 0.75	3
> 0.25 ≤ 0.5	2
> 0 ≤ 0.25	1
0 or no data	0

Total Exposure Consideration (TEC) Score = (2a x 2b) + 2c + 2d

Total Substance (TS) Score = THI Score x TEC Score

3. PRINCIPLES UNDERPINNING HAZARD IDENTIFICATION

3.1 THE APPROACH

The hazard component of the prioritisation methodology includes questions relating to cancer classification and potency, respiratory effects and reproductive, developmental and other non-cancer effects. The questions are consistent with international methodologies used for similar purposes. The approaches used overseas are reviewed in the public consultation draft of this methodology (available on the EPHC website www.ephc.gov.au).

The hazard component of the prioritisation scheme for Tier 2 Air Toxics incorporates a series of questions scoring the severity of effects for the following health endpoints:

- Carcinogenicity;
- Reproductive, developmental and mutagenic effects;
- Respiratory effects including those associated with asthma and chronic lung diseases, sensitisation and respiratory irritation; and
- Multiple organ toxicity;

It is recognised that for a quantitative hazard assessment the treatment of data gaps can be problematic. Therefore, where possible, guidance is provided below outlining multiple data sources that may be used to provide responses for each hazard question.

3.2 APPLICATION

Data for each question within the hazard section of the methodology can be obtained from a number of sources. As well as information databases such as the USEPA IRIS database, where summarised information is available for a large number of pollutants, comprehensive reviews or assessment reports for individual pollutants are also available from a number of sources. Where in-depth reviews are available (usually for specific pollutants of particular interest such as those associated with widespread potential exposure), responses to many of the hazard questions may be obtained from these comprehensive reviews.

Reviews of the hazard information for air toxics are available from the following major sources:

- USEPA Integrated Risk Information System (IRIS) database, available at http://www.epa.gov/iris/;
- Californian EPA Office for Environmental Health Hazard Assessment, Acute and Chronic REL assessments and cancer potency reports, available at http://www.oehha.ca.gov/air.html;
- USEPA National Centre for Environmental Assessment (NCEA), Toxicity profile reports and hazard assessments, available at http://epa.gov/ncea/;
- Australian National Industrial Chemicals Notification and Assessment Scheme (NICNAS) Priority Existing Chemicals (PEC) Assessment Reports, available at http://www.nicnas.gov.au/Publications/CAR/PEC.asp;
- US Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles, available at http://www.atsdr.cdc.gov/toxpro2.html;
- US National Library of Medicine TOXNET Toxicology Data Network, providing access to the Hazardous Substances Databank (HSDB), available at http://toxnet.nlm.nih.gov/index.html;
- US National Toxicology Program (NTP) available at

http://ntp-server.niehs.nih.gov/; and
- WHO International Programme on Chemical Safety (IPCS), providing access to Environmental Health Criteria Monographs (EHC), Concise International Chemical Assessment Documents (CICAD), Health and Safety Guides (HSG), International Chemical Safety Cards (ICSC) and other information, available at http://www.inchem.org/.

Given that the ranking scheme provides a relative ranking it is important that, as far as is practicable, the information source provides information on as many pollutants as possible. Ideally only one comprehensive database would be used as this would ensure internal consistency for identifying and assessing hazards.

The following advice refers to responses to individual questions.

Question 2.1a(i) relates to carcinogenicity and whether a pollutant has been classified as a carcinogen. The relative scoring is dependent on whether it is a known human carcinogen, a probable or possible human carcinogen, or unclassifiable with respect to carcinogenicity in humans. The classifications follow those well established by the International Agency into Research into Cancer (IARC) and the USEPA. These schemes have wide acceptance internationally. If a substance is classified as a known human carcinogen it receives the highest score. If it is unclassifiable with respect to carcinogenicity in humans it scores lowest.

In most situations the IARC and USEPA classifications are consistent. If differences occur then the most recent assessment should be used. However, if the assessments were made at a similar time, preference should be given to the IARC classifications.

Question 2.1a(ii) relates to cancer potency and utilises unit risk factors as a measure. The unit risk factor (URF) is the excess cancer risk associated with an inhalation exposure of 1 $\mu g/m^3$ of a given substance. The greater the unit risk factor, the greater the excess cancer risk.

Unit risk factors are available from a variety of sources including the WHO, USEPA and Californian EPA. Unit risk factors can vary for a variety of reasons including:
- Whether data used are based on data derived from humans or animals; and
- The approach taken to deriving the URF and the assumptions included.

For these reasons, and for the purposes of consistency in ranking of priority air toxics, URFs should be obtained from the same data source whenever possible. The USEPA has the most comprehensive set of URFs for air toxics. This information is available from the IRIS database (www.epa.gov/iris/subst/index.html) and should be used as the primary source of data for this prioritisation process. The WHO has URFs for a limited number of air toxics and should be used as the secondary source of information when data is not available from the USEPA. The Californian EPA Office for Environmental Health Hazard Assessment (OEHHA) also has URFs for a number of air toxics and should be used as the tertiary source of data.

Question 2.1(b) relates to reproductive/developmental/mutagenic potential. Information for the air toxics can be obtained from the USEPA IRIS database. Information is also available from the WHO IPCS documents and the supporting documentation for the acute and chronic RELs from OEHHA at (www.oehha.ca.gov/air.html).

If data are not available from these sources information for these endpoints can be inferred from the presence of the following EU risk phrases obtained from the Annex 1 list of EU dangerous substances at*http://ecb.jrc.it/classification-labelling/ (click on Search ClassLab/Annex 1):*

> Demonstrated effects in humans:
> R46 - May cause heritable genetic damage or R60 - May impair fertility or R61 – May cause harm to the unborn child (Category 1)
>
> Demonstrated effects in animals:
> R46 - May cause heritable genetic damage or R60 - May impair fertility or R61 – May cause harm to the unborn child (Category 2)
>
> Possible effects in animals:
> R40 - Possible risk of irreversible effects or R62 – Possible risk of impaired fertility or R63 - Possible risk of harm to the unborn child (Category 3)

Many of the air toxics affect more than one organ system in the body. Question 2.1 (c) relates to effects on the respiratory system only as this is the key route of exposure for air toxics. The question includes symptoms of increasing severity that range from irritation of the airways to more serious effects such as chronic lung diseases, asthma and COPD. These are effects that have been identified as being associated with air pollution. Much of the information required for this question can be obtained from the IRIS database, WHO IPCS documents or OEHHA REL documentation. However, for some pollutants reviewing primary literature will be required. This literature should be sourced from peer reviewed journals.

Question 2.1(c) relates to pollutants known to have more than one of the listed effects. These pollutants are scored on the most serious of the effects and not all effects. For example, if a pollutant is known to cause irritation of the airways but also is known to cause asthma then it will score 5 in this scheme.

There are several pollutants that are known to have chronic non-cancer health effects. Question 2.1(d) utilises chronic non-cancer air quality guidelines as a measure of the severity of these effect for the purposes of ranking air toxics in a similar way that question 2.1(b) utilises unit risk factors as a measure of cancer potency. A number of data sources can be used and the recommended order of priority is listed below:

- Australian air quality standards/guidelines;
- USEPA Reference concentrations (RfC);
- WHO air quality guidelines;
- Californian EPA OEHHA Chronic Reference Exposure levels; and
- US Agency Toxic Substances and Disease Registry chronic minimal risk levels (MRLs).

Although there are subtle differences across these jurisdictions in the way guideline values are derived, for the purposes of transparency and simplicity, no conversion factors are recommended.

Question 2.1(e) addresses pollutants that affect multiple organs. For example, some pollutants may cause lung cancer but may also affect the liver and kidneys. Such pollutants would score highly on this question. Again, much of the information required for this

question can be obtained from the IRIS database, WHO IPCS documents or OEHHA REL documentation. Information can be derived from either animal or human data.

Question 2.1(f) relates to the potential for bioaccumulation in the body. The evidence for this can come from either human or animal data. The data sources for bioaccumulation potential include the USEPA PBT list, OEHHA REL documentation, ATSDR Toxicological profiles and WHO IPCS documents.

Finally, investigations into the links between exposure to air toxics and adverse health effects are ongoing. Question 2.1(g) provides for other, or emerging, health effects not yet contained within existing databases (e.g. neuro-behavioural effects) to allow for the findings of new research. A search of current peer reviewed literature should be undertaken at the time of applying the methodology to identify any emerging issues that may be relevant to the prioritisation.

4. PRINCIPLES UNDERPINNING EXPOSURE CONSIDERATIONS

4.1 THE APPROACH

The exposure component of the prioritisation methodology adopts surrogate measures of population exposure to air toxics for the purposes of ranking pollutants. These measures of population exposure rely on air emissions inventories for air toxics, and atmospheric fate data. Such measures are consistent with those used in international schemes to prioritise air pollutants.

Air emissions inventories are suitable surrogate measures for estimating population exposure because the inventories indicate the number, type and distribution of sources of air toxics, and the relative amounts of air toxics being emitted into the air each year at any given location. These factors influence population exposure because, in a broad sense, the more of a pollutant that is emitted to air, the greater the likelihood and extent of population exposure. Furthermore, if a pollutant has multiple sources over an entire region, population exposure will be greater because the pollutant will be more widespread and affect a larger proportion of the community than a pollutant limited to a single source or restricted to a few locations.

The atmospheric fate of individual air toxics also has a bearing on population exposure. When released into the atmosphere, some chemicals undergo physical or chemical transformations that can reduce their concentrations, while others are relatively resistant to these changes, so that concentrations remain stable or may increase over time.

The fate variables adopted for this prioritisation methodology are persistence and photochemical reactivity. These two variables were chosen because they influence the time a pollutant remains in the atmosphere, and whether a pollutant forms undesirable secondary products. Air toxics that remain in the air for longer could potentially build up and increase exposure, whereas air toxics producing secondary products increase the concentration of these undesirable products thereby increasing overall exposure to hazardous substances.

4.2 APPLICATION

To determine the relative exposure ranking of individual air toxics, individual substances are scored on the basis of their total annual emissions to air, and whether they are emitted from multiple regional sources, or predominantly from point sources. Additional scores are given for their persistence and photochemical reactivity.

Question 2.2 (a) scores pollutants on the basis of the total amount of emissions to air per year, using NPI emissions data, that have been converted from kilograms/year to tonnes/year for the purposes of scoring.

The aim of the Air Toxics NEPM is to facilitate the collection of ambient concentrations of priority air toxics in a nationally consistent manner. Therefore, the emissions inventory data adopted in the prioritisation methodology to estimate exposure are from the NPI. The NPI is the only national database of emissions presently available that provides a consistent method for estimating emissions. The NPI database is expected to be a primary source of data for any future application of the methodology to prioritise air toxics.

Question 2.2 (b) scores pollutants on the basis of the percentage of emissions that arise from aggregate sources. As the Air Toxics NEPM is focussed on pollutants arising from multiple

sources and not those that are emitted exclusively from individual industrial sources, a greater weighting has been given to those that have been estimated in the NPI to arise predominantly from aggregate sources.

Question 2.2 (c) relates to persistence in the environment. Atmospheric persistence is included in the exposure component of the prioritisation methodology because it is assumed that the more persistent a substance is in the air, the greater the risk of inhalation exposure, since concentrations could build up gradually to high levels under stagnant atmospheric conditions.

The atmospheric half-life due to gas-phase reactions with hydroxyl radicals is adopted as a surrogate for the atmospheric persistence of organic air toxics because, for the majority of organic compounds, this is the dominant chemical loss process in the atmosphere. The atmospheric half-life times for this reaction are calculated from the relevant rate constant and assume a standard temperature and concentration of hydroxyl radicals per volume of air.

For metallic compounds, which are present mainly in particulate form, a default value of 10 days is adopted for persistence, if no other data are available. The default value is based on the estimated average atmospheric residence time for particles (0.1-1 μm) of 5-15 days due to wet and dry deposition (Balkanski et al. 1993), which are the dominant mechanisms by which particles are physically removed from the atmosphere.

For the purposes of prioritisation, using default values is a reasonable approach because the methodology is not concerned with determining absolute values for persistence, but rather with finding a consistent way of ranking chemicals by their relative atmospheric persistence.

The atmospheric half-life times for reaction with hydroxyl radicals are derived from National Library of Medicine Hazardous Substances Data Bank (HSDB) at
http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB.
If no data are available in HSDB, persistence data are adopted from the Californian Air Resource Board's *Toxic Air Contaminant Identification List Summaries*, available at
http://www.arb.ca.gov/toxics/tac/intro.htm?PF=Y).

The scoring criteria for persistence are adopted from the UK Institute for Environment and Health document, *a screening method for ranking chemicals by their fate in the environment and potential toxic effects in humans following non-occupational exposure* (IEH Web Report W14 2004).

Question 2.2 (d) relates to the photochemical smog forming potential of air toxics, which differs significantly between substances. The best measure of this potential is the relative photochemical reactivity of VOCs. Many air toxics are VOCs, and while some of these may not be very toxic themselves, some are photochemically reactive leading to the formation of more toxic substances, including ozone.

The formation of ground-level ozone is a serious air pollution problem in many areas. Ozone is known to have adverse effects on health, making consideration of ozone precursors important. Furthermore, ozone is widely distributed in air, especially during the warm months, when levels commonly exceed current health standards. For these reasons, air toxics are rated additionally for their relative ozone forming potential. The estimates for relative photochemical reactivity have been adopted from those developed by Carter et al (2003) for the Californian EPA Air Resources Board), at
ftp://ftp.cert.ucr.edu/pub/carter/SAPRC99/r02tab.xls.

5. SCORING SCHEME

The scores for the hazard section are added together to give a total score for this component of the methodology. All questions are equally weighted as the potential seriousness of an effect is already accounted for in the individual question scoring.

The scores for question 2.2a and 2.2b are multiplied together to give additional weighting to pollutants that arise from multiple sources and are therefore likely to pose the greatest potential risk to the population due to greater exposure to a pollutant. This combined score is then added to the scores for persistence and photochemical reactivity to give a total score for the exposure component.

The final scores are obtained through multiplying the score for hazard and exposure. This gives a final ranking based on potential risk arising from exposure to these pollutants.

Sensitivity analyses were conducted in the trialling of the methodology to investigate the effect of adding rather than multiplying the hazard and exposure components (as well as questions 2.2a and 2.2b). The outcome of this sensitivity analysis indicated that adding the hazard and exposure components made very little difference to the overall relative ranking but clustered the pollutants more closely together. Multiplying the two components is not only more consistent with risk assessment approaches but also provided a greater distribution in the scores for individual pollutants. This allows a clearer assessment of the relative importance of these pollutants for further consideration for inclusion in the Air Toxics NEPM.

6. OUTCOMES OF TRIAL

The methodology was trialled utilising the NPI pollutants as the starting list. This does not mean that additional pollutants should not be considered in future applications, but for the purposes of trialling the methodology the NPI provided easily accessible emissions data for air toxics from a database with national coverage and using consistent estimation techniques.

All pollutants listed in the NPI were included in the trial, with the exception of the criteria air pollutants, and pollutants emitted only to land and water. The five air toxics already in the Air Toxics NEPM were retained for comparative purposes. The emissions data for the reporting year 2002-03 was used in the trial.

To prioritise pollutants that are potentially of national concern, the trial was conducted using the total annual NPI emissions data from all jurisdictions combined. To identify priority pollutants for individual jurisdictions, and also to identify any differences in the rankings between individual jurisdictions and the national ranking, the methodology was also applied using emissions data from individual States.

Hazard data used in the trial of the methodology came primarily from the USEPA IRIS database, although some information was taken from the Californian EPA OEHHA REL documentation. IARC cancer classifications were also used.

There are no automated databases that contain all of the hazard data that can be easily downloaded. This means that producing the spreadsheets for the hazard ranking was time consuming. The spreadsheets are kept at the NEPC Service Corporation for future use but should be updated as required.

The quality of the exposure estimates in the prioritisation methodology is linked to the quality of the emissions data. The quality of the emissions data in the NPI depends on the methods employed in the estimation, as well as the quantity and accuracy of the data on which the estimations are based. When considering the results of the trial, there are a number of limitations associated with the NPI data that need to be acknowledged.

The trial results indicate there are some pollutants (e.g. lead, cobalt, antimony) that are ranked higher than would be expected from what is known about current sources. We believe this is because emissions from some aggregate sources are overestimated using NPI methods. Because the prioritisation methodology weights exposure from aggregated sources higher than from point sources, any overestimates in aggregated emissions are further magnified in the exposure component. For example, NPI data for 2002-2003 used in the trial, lists dust from paved and unpaved roads as contributing nearly 40% of total emissions of lead and cobalt. Currently, however, the main emissions of lead and cobalt are from industrial sources. Prescribed burning and wildfires were responsible for over 90% of emissions of antimony.

Aggregated emissions from paved and unpaved roads are calculated for the NPI using techniques and methods outlined in the NPI emissions estimation manuals (NPI, 1999a). These methods rely on speciation factors for total suspended particulates (TSP) developed by the US EPA, and Australian VKT data, to estimate emissions of metallic compounds in dust (the reliability of the speciation factors are assessed as medium to low in the manual). Further, the total emissions for metallic compounds reported in the NPI do not distinguish particulate forms from gaseous forms. In reality, dust entrained from roads by vehicles

would not remain suspended in air and be available for exposure, but rather would be rapidly deposited close to roads. For these reasons, emissions of metals form paved and unpaved roads are likely to be overestimated.

A similar argument can be made for emissions of antimony from prescribed burning. Aggregate emission factors for prescribed burning are calculated for the NPI using techniques and methods outlined in the NPI emissions estimation manuals (NPI, 1999b). Speciation factors for antimony are derived from speciation profiles developed in the USA by CARB (CARB, 1991). These factors are considered to be of low reliability.

The NPI also provides a limited list of pollutants. With changes to fuel quality and industrial processes, as well as the introduction and use of alternative fuels, other pollutants not currently on the NPI substance list may become important as air toxics, while others may become less important.

In future applications of the methodology, additional pollutants should be considered for incorporation into the NEPM. There are several lists that are available for consideration and these should be assessed based on what is known in Australia about the emissions of air toxics.

Table 1 presents the results of the national ranking. The five air toxics already in the Air Toxics NEPM ranked in the top 10 (benzene, formaldehyde, PAHs, toluene and xylenes are in the top 10), which is to be expected. However, a small number of substances gave unexpected ranking results. These include: antimony and compounds, dioxins, and ethylene glycol. Explanations for these unexpected results follow Table 1.

Table 1: Outcomes of the trial using the NPI list of substances

Rank	Total Score Hazard	Total Score Exposure	Total score as % of possible score	NPI Substance
1	47	85	61%	Benzene
2	36.5	68	38%	Formaldehyde (methyl aldehyde)
3	38	54	31%	Polycyclic aromatic hydrocarbons
4	29	65	29%	1,3- Butadiene (vinyl ethylene)
5	27	65	27%	Tetrachloroethylene
6	19	84	24%	Toluene (methylbenzene)
8	21	65	21%	Acetaldehyde
9	15	85	19%	Xylenes (individual or mixed isomers)
10	24	51	19%	Trichloroethylene
11	18	64	18%	Ethylbenzene
12	44	25	17%	Ethylene oxide
13	24	43	16%	Antimony & compounds
14	33	28	14%	Cobalt & compounds
15	15	60	14%	n-Hexane
16	46	18	13%	Cadmium & compounds
17	25	30	11%	Manganese & compounds
18	14	49	10%	Ethylene glycol (1,2-ethanediol)
19	13	47	9%	Methyl ethyl ketone
20	12	49	9%	Methyl isobutyl ketone
21	10	54	8%	Chlorine
22	43	12	8%	Nickel & compounds
23	8	59	7%	Methanol
24	13	35	7%	Acetonitrile
25	47	8	6%	Arsenic & compounds
26	14.5	23	5%	Styrene (ethenylbenzene)
27	20	15	5%	Chloroform (trichloromethane)
28	17.5	17	5%	Mercury & compounds
29	41.5	6	4%	Chromium(VI) compounds
30	34	6	3%	Vinyl Chloride Monomer
31	7	29	3%	Dichloromethane
32	3	67	3%	Cyclohexane
33	18	9	2%	Hydrochloric acid
34	18	9	2%	Carbon disulfide
35	26	6	2%	1,2-Dichloroethane
36	22	7	2%	Acrylonitrile (2-propenenitrile)
37	15	10	2%	Phenol
38	4	36	2%	Ammonia (total)
39	6	23	2%	Dibutyl phthalate
40	13.5	10	2%	Cyanide (inorganic) compounds
41	27	5	2%	Benzene hexachloro- (HCB)
42	7	18	2%	Cumene (1-methylethylbenzene)
44	1	100	2%	Total Volatile Organic Compounds (VOC)
45	14	7	1%	Methyl methacrylate
46	32	3	1%	Acrylamide
47	22	4	1%	Toluene-2,4-diisocyanate
48	31	5	2%	1,2-Dibromoethane
49	14	6	1%	Acrylic acid
50	19	4	1%	Selenium & compounds
51	1	69	1%	Acetone
52	6	10	1%	Hydrogen sulfide
53	19	3	1%	Methylenebis (phenylisocyanate)
54	1	44	1%	2-Ethoxyethanol acetate
55	5.5	8	1%	Chromium(III) compounds
56	41.5	1	1%	Beryllium & compounds
57	1	40	1%	Nitric acid
58	7.5	5	1%	Biphenyl (1,1-biphenyl)
59	7	5	1%	Chloroethane (ethyl chloride)
60	10	3	0%	4,4?-Methylene-bis(2-chloroaniline) (MOCA)
61	1	24	0%	Zinc and compounds
62	22	1	0%	Nickel carbonyl

Antimony and Compounds

Antimony ranked 14 in the trial prioritisation. Antimony has not been assessed for carcinogenicity so did not score for these questions. There have been reproductive and developmental effects in humans and it is known to affect multiple organ systems and causes chronic lung disease, respiratory irritation and exacerbates existing conditions and therefore scored highly on this question. An air quality guideline has been established and it is uncertain whether it bio-accumulates. The total score for hazard was 24 out of a possible 61. The NPI estimates indicate that 103 tonnes per year of antimony are released and 98% are from aggregate sources (i.e. prescribed burning, wildfires). Antimony is also known to be persistent in the environment for up to 4 days and is not known to have any photochemical smog forming potential. The score for exposure was 43 out of a possible 109. The overall score for antimony was approximately 16% of the total possible score.

Dioxins

Dioxins scored low in the overall ranking because of the very low exposure score. In the ranking scheme dioxins ranked highly on hazard. The total score on hazard was based on TCDD. It scored highest on carcinogenicity (known human carcinogen), reproductive and developmental effects, multiple organ systems effects and bioaccumulation. No air quality guideline has been established for dioxins, so no score could be assigned for this question. The total score for hazard was 39 out of a possible score of 61. For exposure, dioxins scored low (less than 1) due to very low annual emissions. The total tonnes/year emitted nationally was 0.0004. Approximately 50% of these emissions came from aggregate sources.

Ethylene Glycol

Ethylene glycol ranked 19 in the trial prioritisation. Ethylene glycol has not been assessed for carcinogenicity so did not score for these questions. It has reproductive and developmental effects in animals and it is known to affect multiple organ systems and cause respiratory irritation. An air quality guideline has been established and it is uncertain whether it bio-accumulates. The total score for hazard was 14 out of a possible 61. The NPI estimates indicate that nationally 1,200 tonnes per year of ethylene glycol are released, with 88% comes from aggregate sources (e.g. architectural coatings, solvents). Ethylene glycol is also known to be persistent in the environment for up to 4 days and has low photochemical smog forming potential. The score for exposure was 49 out of a possible 109. The overall score for ethylene glycol was approximately 10% of the total possible score.

The prioritisation procedure was also trialled for individual jurisdictions emissions. Although the absolute rankings for the pollutants changed slightly from jurisdiction to jurisdiction, there was general consistency in the pollutants that ranked within the top 30. The rankings for the individual jurisdictions are presented in Attachment 1.

7. RECOMMENDATIONS

1. Starting List

The NPI list is a subset of pollutants emitted into the air environment in Australia. Changes in fuels and industrial processes since the NPI was established may mean that other pollutants should be considered in the prioritisation process. Therefore,It is recommended that a range of lists, in addition to the NPI, be considered as a starting point in the prioritisation. These include:

- USEPA list;
- OEHHA list;
- EPA Victoria list (State of Knowledge Report on Hazardous Air Pollutants 1999);
- Air Toxics Program Environment Australia;
- State Environment Protection Policy (Air Quality Management) EPA Victoria;
- USEPA 16 priority PAHs;
- WHO '97 list (dioxins, PCB's);
- NSW regulatory list;
- Jurisdiction inventories;
- Jurisdiction regulations and standards; and
- AAQ and AT NEPM pollutants.

When applying the methodology in future, it is recommended that the most up-to-date emissions inventory data for air toxics be used in the evaluation of exposure. This may be either NPI or jurisdictional inventories.

Additional information on pollutants may also be found from other sources not listed above, for example, NICNAS reports on new and existing chemicals used in Australia. These reports generally include the chemical's usage volume. Emissions factors for converting the usage volumes of pollutants to tonnes emissions to air may be found in the USEPA's Compilation of Air Pollutant Emission Factors, better known as AP 42. These are available online at http://www.epa.gov/ttn/chief/ap42/index.html

2. the methodology be applied at the mid-term review of the Air Toxics NEPM scheduled for 2006;

3. the methodology should be applied as an initial ranking of priority pollutants;

4. the hazard component in the spreadsheet should be updated to take into account any updated information on the health effects of the pollutants under consideration;

5. in selecting pollutants for inclusion in the Air Toxics NEPM that a more detailed analysis of the exposure (including consideration of potentially exposed populations) be conducted for pollutants that fall within the top 20 (excluding those already in the NEPM) so that a more informed decision can be made on the need to include the pollutants based on the potential risk posed to the Australian population;

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ATTACHMENTS:

RESULTS OF PRIORITISATION FOR INDIVIDUAL JURISDICTIONS

National	NSW	Victoria	Queensland	Western Australia
Benzene	Benzene	Benzene	Benzene	Benzene
Formaldehyde (methyl aldehyde)	Toluene (methylbenzene)	Formaldehyde (methyl aldehyde)	Formaldehyde (methyl aldehyde)	1,3- Butadiene (vinyl ethylene)
Polycyclic aromatic hydrocarbons	Formaldehyde (methyl aldehyde)	Toluene (methylbenzene)	Toluene (methylbenzene)	Acetaldehyde
1,3- Butadiene (vinyl ethylene)	Tetrachloroethylene	1,3- Butadiene (vinyl ethylene)	1,3- Butadiene (vinyl ethylene)	Cobalt & compounds
Tetrachloroethylene	Xylenes (individual or mixed isomers)	Lead & compounds	Tetrachloroethylene	Formaldehyde (methyl aldehyde)
Toluene (methylbenzene)	1,3- Butadiene (vinyl ethylene)	Tetrachloroethylene	Ethylene oxide	Lead & compounds
Acetaldehyde	Polycyclic aromatic hydrocarbons	Polycyclic aromatic hydrocarbons	Xylenes (individual or mixed isomers)	Cadmium & compounds
Xylenes (individual or mixed isomers)	Methyl ethyl ketone	Xylenes (individual or mixed isomers)	Ethylbenzene	Manganese & compounds
Trichloroethylene	Methanol	Trichloroethylene	n-Hexane	Toluene (methylbenzene)
Ethylbenzene	Arsenic & compounds	Acetaldehyde	Acetaldehyde	Xylenes (individual or mixed isomers)
Ethylene oxide	Hydrochloric acid	n-Hexane	Methyl ethyl ketone	Antimony & compounds
Antimony & compounds	Ethylene oxide	Styrene (ethenylbenzene)	Methyl isobutyl ketone	Polycyclic aromatic hydrocarbons
Cobalt & compounds	Nickel & compounds	Ethylbenzene	Methanol	Tetrachloroethylene
n-Hexane	1,2-Dibromoethane	Ethylene oxide	Ethylene glycol (1,2-ethanediol)	Ethylbenzene
Cadmium & compounds	Manganese & compounds	Methyl ethyl ketone	Polycyclic aromatic hydrocarbons	Methyl ethyl ketone
Lead & compounds	Trichloroethylene	Ethylene glycol (1,2-ethanediol)	Trichloroethylene	Ethylene oxide
Ethylene glycol (1,2-ethanediol)	Vinyl Chloride Monomer	Chromium(VI) compounds	Chloroform (trichloromethane)	Chlorine
Chlorine	Acetaldehyde	Arsenic & compounds	Lead & compounds	Ethylene glycol (1,2-ethanediol)
Nickel & compounds	Sulfur dioxide	Ammonia (total)	Dichloromethane	Methanol
Acetonitrile	Ethylene glycol (1,2-ethanediol)	Methanol	Cyclohexane	Chromium(VI) compounds
Arsenic & compounds	Ethylbenzene	Methyl isobutyl ketone	Styrene (ethenylbenzene)	n-Hexane
Styrene (ethenylbenzene)	Cyanide (inorganic) compounds	Vinyl Chloride Monomer	Vinyl Chloride Monomer	Mercury & compounds
Chloroform (trichloromethane)	Methyl isobutyl ketone	Cadmium & compounds	1,2-Dibromoethane	Chloroform (trichloromethane)
Chromium(VI) compounds	Mercury & compounds	Acrylonitrile (2-propenenitrile)	Dibutyl phthalate	Trichloroethylene
Vinyl Chloride Monomer	Chloroform (trichloromethane)	1,2-Dibromoethane	1,2-Dichloroethane	Methyl isobutyl ketone
Dichloromethane	Total Volatile Organic Compounds (VOC)	Nickel & compounds	Nickel & compounds	Arsenic & compounds
Cyclohexane	Acrylamide	Cyclohexane	Ammonia (total)	Nickel & compounds
Methyl ethyl ketone	Acrylonitrile (2-propenenitrile)	Manganese & compounds	Sulfur dioxide	Styrene (ethenylbenzene)
Manganese & compounds	Toluene-2,4-diisocyanate	Hydrochloric acid	Acrylonitrile (2-propenenitrile)	Dichloromethane
Carbon disulfide	Acrylic acid	Chlorine	Cyanide (inorganic) compounds	Phenol
Hydrochloric acid	Carbon disulfide	Carbon disulfide	Hydrochloric acid	Selenium & compounds
1,2-Dichloroethane	Lead & compounds	Sulfur dioxide	Manganese & compounds	1,2-Dibromoethane
1,2-Dibromoethane	Methyl methacrylate	Dichloromethane	Total Volatile Organic Compounds (VOC)	Carbon disulfide
Acrylonitrile (2-propenenitrile)	Nickel carbonyl	Chloroform (trichloromethane)	Acrylamide	1,2-Dichloroethane
Phenol	Dichloromethane	Methyl methacrylate	Antimony & compounds	Cyanide (inorganic) compounds
Ammonia (total)	Phenol	Acrylamide	Arsenic & compounds	Cyclohexane
Dibutyl phthalate	Styrene (ethenylbenzene)	Total Volatile Organic Compounds (VOC)	Cadmium & compounds	Sulfur dioxide
Benzene hexachloro- (HCB)	Cadmium & compounds	Toluene-2,4-diisocyanate	Carbon disulfide	Total Volatile Organic Compounds (VOC)
Cyanide (inorganic) compounds	Hydrogen sulfide	Acrylic acid	Phenol	Acrylamide
Mercury & compounds	Chromium(VI) compounds	Cyanide (inorganic) compounds	Toluene-2,4-diisocyanate	Hydrochloric acid
Cumene (1-methylethylbenzene)	Acetone	Phenol	Acrylic acid	Acrylonitrile (2-propenenitrile)
Sulfur dioxide	Selenium & compounds	Antimony & compounds	Methyl methacrylate	Acrylic acid
Total Volatile Organic Compounds (VOC)	Cobalt & compounds	Acetonitrile	Chromium(VI) compounds	Methyl methacrylate
Acrylamide	Ammonia (total)	Cumene (1-methylethylbenzene)	Chlorine	Vinyl Chloride Monomer
Toluene-2,4-diisocyanate	Biphenyl (1,1-biphenyl)	Acetone	Mercury & compounds	Cumene (1-methylethylbenzene)
Acrylic acid	Chloroethane (ethyl chloride)	Methylenebis (phenylisocyanate)	Cobalt & compounds	Toluene-2,4-diisocyanate
Selenium & compounds	Cumene (1-methylethylbenzene)	Mercury & compounds	Acetonitrile	Acetone
Acetone	Antimony & compounds	Hydrogen sulfide	Hydrogen sulfide	Zinc and compounds
Methanol	Fluoride compounds	Chloroethane (ethyl chloride)	Beryllium & compounds	Hydrogen sulfide
Methylenebis (phenylisocyanate)	Cyclohexane	2-Ethoxyethanol acetate	Acetone	Chromium(III) compounds
Methyl isobutyl ketone	1,1,1,2-Tetrachloroethane	Biphenyl (1,1-biphenyl)	Cumene (1-methylethylbenzene)	Beryllium & compounds
2-Ethoxyethanol acetate	Chlorine	Nickel carbonyl	2-Ethoxyethanol acetate	2-Ethoxyethanol acetate
Chromium(III) compounds	Dibutyl phthalate	1,1,2-Trichloroethane	Chloroethane (ethyl chloride)	Chloroethane (ethyl chloride)
Beryllium & compounds	2-Ethoxyethanol	Dibutyl phthalate	Biphenyl (1,1-biphenyl)	Ammonia (total)
Nitric acid	Chromium(III) compounds	Fluoride compounds	Nickel carbonyl	Biphenyl (1,1-biphenyl)
Biphenyl (1,1-biphenyl)	Ethyl acetate	2-Ethoxyethanol	1,1,1,2-Tetrachloroethane	1,1,2-Trichloroethane
Chloroethane (ethyl chloride)	Ethanol	Ethyl acetate	1,1,2-Trichloroethane	Copper & compounds

South Australia	Tasmania	ACT	NT
Benzene	Formaldehyde (methyl aldehyde)	Benzene	Benzene
Formaldehyde (methyl aldehyde)	Benzene	Formaldehyde (methyl aldehyde)	Formaldehyde (methyl aldehyde)
Acetaldehyde	Hydrochloric acid	Toluene (methylbenzene)	Acetaldehyde
1,3- Butadiene (vinyl ethylene)	Polycyclic aromatic hydrocarbons	Acetaldehyde	Toluene (methylbenzene)
Polycyclic aromatic hydrocarbons	Acetaldehyde	Lead & compounds	1,3- Butadiene (vinyl ethylene)
Tetrachloroethylene	1,3- Butadiene (vinyl ethylene)	Xylenes (individual or mixed isomers)	Xylenes (individual or mixed isomers)
Toluene (methylbenzene)	Toluene (methylbenzene)	Polycyclic aromatic hydrocarbons	Ethylene oxide
Lead & compounds	Cyanide (inorganic) compounds	1,3- Butadiene (vinyl ethylene)	n-Hexane
Trichloroethylene	Xylenes (individual or mixed isomers)	Tetrachloroethylene	Chlorine
n-Hexane	Lead & compounds	Ethylene oxide	Acetonitrile
Xylenes (individual or mixed isomers)	Tetrachloroethylene	n-Hexane	Ethylbenzene
Ethylbenzene	Ethylene oxide	Ethylbenzene	Tetrachloroethylene
Ethylene oxide	n-Hexane	Methyl ethyl ketone	Lead & compounds
Styrene (ethenylbenzene)	Methyl ethyl ketone	Methanol	Polycyclic aromatic hydrocarbons
Ethylene glycol (1,2-ethanediol)	Ethylbenzene	Ethylene glycol (1,2-ethanediol)	Manganese & compounds
Methanol	Methanol	Styrene (ethenylbenzene)	Methanol
Chromium(VI) compounds	Ethylene glycol (1,2-ethanediol)	Trichloroethylene	Phenol
Cobalt & compounds	Phenol	Sulfur dioxide	Methyl ethyl ketone
Methyl ethyl ketone	Styrene (ethenylbenzene)	Dichloromethane	Cyanide (inorganic) compounds
Chloroform (trichloromethane)	Dichloromethane	Methyl isobutyl ketone	Ethylene glycol (1,2-ethanediol)
Manganese & compounds	Methyl isobutyl ketone	Cyclohexane	Styrene (ethenylbenzene)
Antimony & compounds	Sulfur dioxide	1,2-Dichloroethane	Methyl isobutyl ketone
Nickel & compounds	1,2-Dibromoethane	Chloroform (trichloromethane)	Cumene (1-methylethylbenzene)
Methyl isobutyl ketone	Vinyl Chloride Monomer	Cumene (1-methylethylbenzene)	Vinyl Chloride Monomer
Dichloromethane	Cyclohexane	Acrylonitrile (2-propenenitrile)	1,2-Dichloroethane
Cyclohexane	1,2-Dichloroethane	Acrylic acid	Ammonia (total)
1,2-Dibromoethane	Nickel & compounds	Methyl methacrylate	Cyclohexane
Arsenic & compounds	Carbon disulfide	Total Volatile Organic Compounds (VOC)	Chloroform (trichloromethane)
Mercury & compounds	Trichloroethylene	Antimony & compounds	Dichloromethane
Cadmium & compounds	Chloroform (trichloromethane)	Carbon disulfide	Sulfur dioxide
Vinyl Chloride Monomer	Manganese & compounds	Phenol	Carbon disulfide
Benzene hexachloro- (HCB)	Acrylamide	Chromium(III) compounds	Acrylonitrile (2-propenenitrile)
1,2-Dichloroethane	Acrylonitrile (2-propenenitrile)	Cyanide (inorganic) compounds	Acrylic acid
Carbon disulfide	Toluene-2,4-diisocyanate	Mercury & compounds	Chromium(VI) compounds
Hydrochloric acid	Acrylic acid	Acetone	Antimony & compounds
Sulfur dioxide	Methyl methacrylate	Hydrochloric acid	Trichloroethylene
Acrylamide	Dibutyl phthalate	2-Ethoxyethanol acetate	Mercury & compounds
Phenol	Antimony & compounds	Hydrogen sulfide	Arsenic & compounds
Acrylonitrile (2-propenenitrile)	Total Volatile Organic Compounds (VOC)	Biphenyl (1,1-biphenyl)	Acetone
Toluene-2,4-diisocyanate	Acetone	Ethanol	Nickel & compounds
Acrylic acid	Mercury & compounds	Ammonia (total)	Nitric acid
Methyl methacrylate	Arsenic & compounds	Zinc and compounds	Total Volatile Organic Compounds (VOC)
Cumene (1-methylethylbenzene)	Hydrogen sulfide	Fluoride compounds	Hydrogen sulfide
Total Volatile Organic Compounds (VOC)	Chloroethane (ethyl chloride)	Ethyl acetate	Ethanol
Cyanide (inorganic) compounds	Cumene (1-methylethylbenzene)	Acetic acid (ethanoic acid)	Chloroethane (ethyl chloride)
Acetonitrile	2-Ethoxyethanol acetate	Arsenic & compounds	Biphenyl (1,1-biphenyl)
Methylenebis (phenylisocyanate)	Ammonia (total)	Beryllium & compounds	Nickel carbonyl
Acetone	Biphenyl (1,1-biphenyl)	Cadmium & compounds	1,1,2-Trichloroethane
Ammonia (total)	Nickel carbonyl	Chromium(VI) compounds	Hydrochloric acid
Hydrogen sulfide	1,1,2-Trichloroethane	Cobalt & compounds	Ethyl acetate
4,4?Methylene-bis(2-chloroaniline) (MOCA)	Fluoride compounds	Copper & compounds	2-Ethoxyethanol acetate
Chloroethane (ethyl chloride)	Chlorine	Di-(2-ethylhexyl) phthalate (DEHP)	Chromium(III) compounds
2-Ethoxyethanol acetate	Ethanol	Magnesium oxide fume	Fluoride compounds
Biphenyl (1,1-biphenyl)	Zinc and compounds	Manganese & compounds	Zinc and compounds
Nickel carbonyl	Ethyl acetate	Nickel & compounds	Boron & compounds
1,1,1,2-Tetrachloroethane	Acetic acid (ethanoic acid)	Polychlorinated dioxins and furans	Copper & compounds
1,1,2-Trichloroethane	Copper & compounds	Selenium & compounds	Magnesium oxide fume

2-Methoxyethanol
Selenium & compounds
Dibutyl phthalate
Chromium(III) compounds
Zinc and compounds
Chlorine
Fluoride compounds
Ethyl acetate
2-Ethoxyethanol
Aniline (benzenamine)
Copper & compounds
Ethanol
Acetic acid (ethanoic acid)
2-Methoxyethanol acetate
Chlorophenols (di, tri, tetra)
Ethyl butyl ketone
Sulfuric acid
Magnesium oxide fume
Beryllium & compounds
Boron & compounds
Chlorine dioxide
Di-(2-ethylhexyl) phthalate (DEHP)
Glutaraldehyde
Nickel subsulfide
Nitric acid
Organo-tin compounds
Phosphoric acid
Polychlorinated dioxins and furans

Magnesium oxide fume
Beryllium & compounds
Boron & compounds
Cadmium & compounds
Chlorine dioxide
Chromium(III) compounds
Chromium(VI) compounds
Cobalt & compounds
Di-(2-ethylhexyl) phthalate (DEHP)
Nickel subsulfide
Phosphoric acid
Polychlorinated dioxins and furans
Selenium & compounds
Sulfuric acid

Sulfuric acid
Beryllium & compounds
Cadmium & compounds
Cobalt & compounds
Di-(2-ethylhexyl) phthalate (DEHP)
Glutaraldehyde
Nickel subsulfide
Organo-tin compounds
Polychlorinated dioxins and furans
Selenium & compounds