

Definition for Volatile Organic Compounds (VOCs)

TOTAL VOCs AND THE NPI

INTRODUCTION

For the purposes of the National Pollutant Inventory, Total Volatile Organic Compounds (VOC's) has been included as a Table 2 reportable substance because it represents photochemical smog precursors, and as such can be generally defined as "any organic compound that participates in atmospheric photochemical reactions."

The intent of the inclusion of Total VOC is in recognition of the combined effect of compounds that contribute to smog formation that may not otherwise have been captured due to individual substances not meeting a usage threshold in their own right. The most common sources of Total VOC's emissions are from the storage and use of liquid and gaseous fuels, the storage and use of solvents and the combustion of fuels.

A pragmatic definition of Total VOCs is offered below, drawing on a number of earlier sources, for the purposes of reporting to the NPI.

VOC DEFINITION

Any chemical compound based on carbon chains or rings (and also containing hydrogen) with a vapour pressure greater than 2mm of mercury (0.27 kPa) at 25^o C, excluding methane.

Note :

1. These compounds may contain oxygen, nitrogen and other elements, but specifically excluded are carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonate salts

TOTAL VOCs IN FUEL MIXTURES

Most fossil fuels consist of a mixture of a number of different carbon compounds and other substances. In many fuels, some of these carbon compounds will meet the above Total VOC definition, while others will not.

Hence it is not possible to describe a particular fuel as a VOC. Rather it is necessary to describe what percentage of the fuel is made up of VOCs.

Table 1 provides details of the VOC (and other selected substances) content of various fuels. Note that the data is indicative only and does not reflect the variability across fuel types used throughout Australia. Local data should be substituted where available.

Table 1: INDICATIVE AUSTRALIAN FUEL COMPOSITION FOR VARIOUS NPI SUBSTANCES

% mass	PULP ¹⁰	ULP ¹⁰	LP ¹⁰	Avgas ¹⁰	Kerosene ⁹	Diesel ⁹	Heating Oil ⁹	Fuel Oil F143 ⁹
Benzene	4.3	3.7	3.6	1.3	0.01	0.06	-	-
Cumene	0.6	0.8	ND	ND	5.57*	1.93*	-	0.43*
Cyclohexane	0.7	0.5	0.12 ⁹	ND	#	#	-	-

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% mass	PULP ¹⁰	ULP ¹⁰	LP ¹⁰	Avgas ¹⁰	Kerosene ⁹	Diesel ⁹	Heating Oil ⁹	Fuel Oil F143 ⁹
Ethylbenzene	2.3	1.7	1.2	ND	0.38	0.19	0.07	-
n-hexane	2.5	3.0	2.2	ND	#	#	-	-
Pb and compounds	0.0001	0.001	0.019	0.073	.-	.-	-	-
PAH [^]	ND	0.3	0.3	ND	0.43	0.42	0.80	0.47
toluene	13.5	12.2	11.0	1.6	0.24	0.15	0.08	-
xylenes	14.9	12.6	11.3	0.7	2.61	0.39	0.33	-
Total VOC	>99	>99	>99	ND	38	7.6	12	3.0

* all C3-alkylated benzene isomers

grouped in C6-C10 compounds

[^] EPA priority PAH

ND = No Data

TOTAL VOCs IN SOLVENTS AND OTHER PRODUCTS

In a similar way to fuels, VOCs are often a component of products such as paints and solvents. The Material Safety Data Sheet is often the best means of identifying the VOC content of a certain product.

TOTAL VOCs THRESHOLDS

There are two NPI thresholds relating to VOCs:

Category 1a

This threshold is tripped if, at a facility, 25 tonnes or more of Total VOCs is used in the reporting period.

For example, if a facility uses 300 tonnes per year of a fuel that consists of 10% VOCs by weight, then it is said to use 30 tonnes (300 x 10/100) of VOCs and hence trips this threshold.

There is one exemption to this definition. For bulk storage facilities, the threshold is only exceeded if their design capacity also exceeds 25 kilotonnes. It is important to note that this only applies to facilities solely engaged in bulk storage.

Category 2

This threshold is tripped if, at a facility, 400 tonnes or more of fuel or waste is burnt in the reporting period; or 1 tonne or more of fuel or waste is burnt in any hour (peak hourly usage) during the reporting period.

If this threshold is tripped, the facility is required to report emissions of a range of substances, including Total VOCs.

TOTAL VOCs EMISSIONS

Industry handbooks for the NPI provide emission estimation techniques for estimating VOCs from fuel burning, fuel storage and other solvent use.

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For fuel storage, all losses from breathing and refilling are to be regarded as Total VOCs emissions.

For use of solvents, paints and other such products, the Total VOCs emissions often are equal to the Total VOCs content of the product. These emissions may be reduced by techniques such as vapor recovery.

TOTAL VOCs SPECIES

Some substances included on the NPI Reporting List (Table 1 and Table 2) fall under the Total VOCs definition. These are outlined below. It is important to note that the reason for their inclusion as individual substances is on the basis of their toxicity to plant, animal and human health, not because of their activity as a precursor to the formation of smog.

For an extensive (indicative) list of potential substances that could be classed as Total VOC's refer to http://www.smitheng.com/voc_list.htm. Note that this list includes methane, which is excluded from the above definition.

Examples of Total VOCs from the NPI Reporting List (Table 2).

Table 1 or 2*	Substance	CASR Number	Table 1 or 2*	Substance	CASR Number
2	Acetaldehyde	75-07-0	2	Ethylene oxide	72-21-8
2	Acetic acid (ethanoic acid)	64-19-7	2	Di-(2-Ethylhexyl) phthalate (DEHP)	117-81-7
1	Acetone	67-64-1	2	Formaldehyde (methyl aldehyde)	50-00-0
2	Acetonitrile	75-05-8	2	n- Hexane	110-54-3
2	Acrylonitrile (2-propenenitrile)	107-13-1	2	Methanol	67-56-1
2	Aniline (benzenamine)	62-53-3	1	2- Methoxyethanol	109-86-4
1	Benzene	71-43-2	2	2- Methoxyethanol acetate	110-49-6
2	Chloroethane (ethyl chloride)	75-00-3	2	Methyl ethyl ketone	78-93-3
2	Chloroform (trichloromethane)	67-66-3	1	Methyl isobutyl ketone	108-10-1
2	Cumene (1-methylethylbenzene)	98-82-8	1	Methyl methacrylate	80-62-6
2	Cyclohexane	110-82-7	1	4,4- Methylene bis 2,4 aniline (MOCA)	101-14-4
1	1,2- Dibromoethane	106-93-4	2	Methylene bis (phenylisocyanate)	101-68-8
2	1,2- Dichloroethane	107-06-2	1	Styrene (ethenylbenzene)	100-42-5
1	Dichloromethane	75-09-2	1	1,1,1,2- Tetrachloroethane	630-20-6
2	Ethanol	64-17-5	2	Tetrachloroethylene	127-18-4
1	2- Ethoxyethanol	110-80-5	1	Toluene (methylbenzene)	108-88-3
1	2- Ethoxyethanol acetate	111-15-9	1	1,1,2- Trichloroethane	79-00-5
2	Ethyl acetate	141-78-6	2	Trichloroethylene	79-01-6
2	Ethyl butyl ketone	106-35-4	1	Vinyl Chloride Monomer	75-01-4
2	Ethylbenzene	100-41-4	2	Xylenes (individual or mixed isomers)	1330-20-7

* Note that all Table 1 substances are included in Table 2.

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References

1. USEPA, AP-42 1996.
2. "Measurement of Motor Vehicle Pollutants and Fleet Average Emission Factors in Melbourne," EPA Publication No. 652, June 1999.
3. "Volatile Organic Compounds in the Ambient Air of Greater Vancouver 1990 to 1996," Greater Vancouver District, Air Quality Department, 1999.
4. Report on the Kalgoorlie NPI Trial, 1999.
5. Correspondence from South Australian and Tasmanian NPI Teams
6. National Pollutant Inventory database, Contextual Information (http://www.environment.gov.au/epg/npi/road_test.html)
7. CRC Handbook of Chemistry & Physics.
8. Merck Index.
9. Ms Natalie Smrk, BP Australia Marketing and Technical Services.
10. Source: "NPI Gasoline Speciation", 1999 AIP.