Submission

CONSULTATION REGULATION IMPACT STATEMENT

Reducing Emissions from Non-Road Spark Ignition Engine & Equipment

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Prepared by the Non-Road Engines Working Group on behalf of the Environment Protection and Heritage Council

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Consultation RIS Reducing Emissions-Non Road Spark Engines & Equipment

Contents

Consultation RIS Reducing Emissions-Non Road Spark Engines & Equipment

Preamble

This consultation regulation impact statement (RIS) states that presently there are no national regulations in Australia that restrict emissions from any non-road spark ignition equipment and engines. The result is a potential for adverse impacts on human health and the environment from emissions from non-road spark ignition engines.

Executive Summary

It's been a well-known fact that when tighter USA emissions standards for non-road spark emission equipment were enacted, other countries would be used to "dump" non- compliant off road engines. So why is Australia still accepting these 2- stroke carburettor engines (together with Australia manufactured 2- stroke motor mowers), all of which fail to comply with either USA or EU emission standards for these engines?

This consultation paper discusses various measures/scenarios to mitigate the importation of cheaper high emitting products such as 2-stroke personal watercraft and garden equipment (sales increase from 53% in 2002 to 59% in 2006) into unregulated Australia market. One of the measures discussed to reduce these high levels of toxic emission was to enact a State based regulation. My view is that this measure should not be considered and that a consistent national emission standard is needed by regulation from Commonwealth legislation for reducing emissions from Non-Road Spark Engines & Equipment

Also the consultation paper considered a proposal to implement an Average Banking Trading System (ABT) for import of Non-Road Spark Engines & Equipment engines. Adoption of this measure would have allowed import of high emission 2- stroke engines into Australia. However, if Australia enacts the latest USA emission standards by implementing Commonwealth legislation for off road spark engines, importation, these high emission engines will cease

A non-phased emission standard option for off road spark ignition engines in Australia is in my view of the most benefit, despite showing only a small savings in NPV compared to implementing a phased emission standard approach.

A negative for adopting a phased emission standard in Australia is that its implementation will lag well behind a final USA standard for these engines. The result is that there will be a period where USA companies will be able to these sell non compliant off road spark ignition engines in Australia. Moreover, a phased approach to implement more stringent emission standards will result in additional health costs and disadvantage manufacturers who are complying with new emission standards (US Final Rule 2006). Refer to health table 2 page 5 .

Conclusions

The Outboard (OB-1a), Personal Water Craft (PWC-1a) and Garden (Grd-1a) option for a *"non-phased"* (one-step) approaches is recommended. See Table 1 below

This non-phased option represents the earliest practicable timetable (2012) for implementing national standards for outboard engines, personal watercraft and garden equipment, respectively, taking into account Commonwealth legislative processes.

Consultation RIS Reducing Emissions-Non Road Spark Engines & Equipment
Conclusion *(Cont)*

Table 1 Policy scenario for Commonwealth legislation of Non Phased Option for Garden & Marine Non Road Spark Engines

Source: Extract from Table 7.4 page *60 "Consultation RIS Reducing Emissions-Non Road Spark Engines & Equipment"* EHPC 5/2010

Scenario name	Engines/equipment covered and approach	Scenario description
OB-1a	Outboard Engines Non-phased	US Final Rule outboard exhaust and evaporative emission standards implemented in Australia from 2012
PWC-1a	Personal Watercraft Non-phased	US Final Rule personal watercraft exhaust and evaporative emission standards implemented in Australia from 2012
Grd-1a2	Garden Equipment Nonphased	US 2006 gardening equipment exhaust emission implemented in Australia from 2012, with US Final Rule gardening equipment evaporative emission standards implemented in Australia from 2012

Recommend:

The USA emission standards for off road spark emission engines [Final Rule] be implemented in Australia by a non-phased approach, through Commonwealth regulation to take effect in 2012 or as soon as practicable and introduce measures to review after two years after the first set of standards comes into legislative effect and then every five years thereafter.

Consultation RIS Reducing Emissions-Non Road Spark Engines & Equipment

1. Gardening Equipment Engines

1.1: Introduction

The consultation paper states that "*--Australian garden equipment is generally not compliant with US 2006 (Phase 2) emission standards--* "and "*--likely that some of these would not comply with the more stringent US Final Rule standards. This equipment would no longer be available for purchase in Australia*

1.2: Volatile Organic Compounds (VOC) Emissions from Gardening Equipment Engines

The results from a preliminary study*"Pilot Study on Lawn Mowers"*[11] in 2006 by the Queensland Heath Scientific Service (QHSS) using active sampling technique, indicate that aged petrol 2-stroke push mowers exposed an operator to benzene levels up to 600 ug/m3 and toluene and xylenes levels up to 1500 ug/m3. Moreover, high levels of benzene, toluene and xylene were also measured when using line trimmers while 4-stroke mowers produced lower amounts of VOCs. These results demonstrate potentially hazardous VOC's exposure of operators using of garden equipment powered by 2-stroke petrol engines. Refer to Table 2. "Health exposure limits VOC's"

A later study by QHSS *"Exposure of Operators to Air Pollutants from Lawn and Garden Equipment"* [10] which used passive sampler badges (See Figure 4 below for 2-StrokeWipper Snippers & Mowers) found significant emission differences between types of garden equipment were .The study recorded high ambient air emission levels of hexane, benzene, toluene, ethylbenzene, Xylene and trimethylbenzene using 2-stroke push mowers. Whereas lower amounts of VOCS were produced by the 4-stroke ride-on mowers. Refer to Appendix A Table 1 for full VOC emission data.

Figu**re 4: VOC Emissions Two Stroke Garden Equipment**

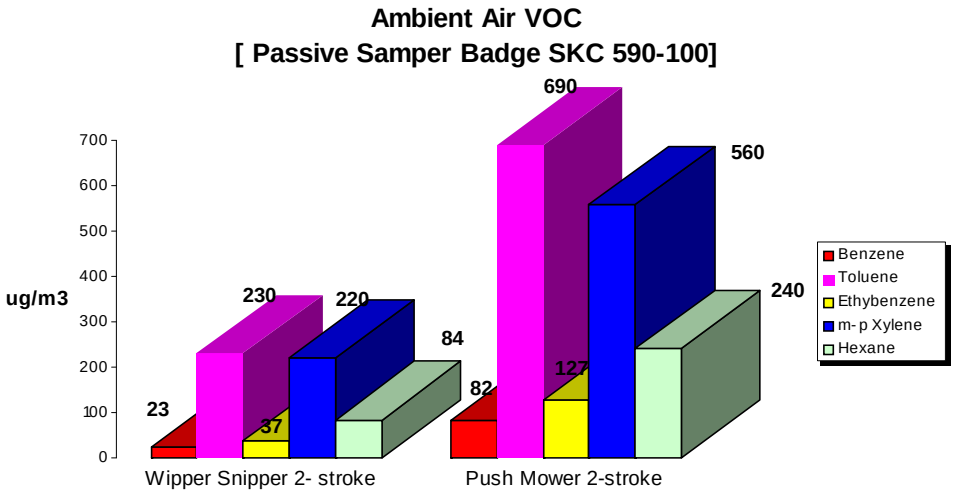


Table2: HSIS Exposure Limit for Selected VOC's

Compound	**TWA mg/m3 = 10 ug/m3**	**STEL mg/m3 =10 ug/m3**
n-Hexane	72	-
Benzene	32	-
Toluene	191	574
Ethylbenzene	434	543
Xylene	350	655
Trimethylbenzene	123	-

Source Table **Exposure of Operators to Air Pollutants from Lawn and Garden Equipment** [10]

Consultation RIS Reducing Emissions-Non Road Spark Engines & Equipment
1. Gardening Equipment Engines
1.3: Conclusions
The results from the Australian study by QHSS " Exposure *of Operators to Air Pollutants from Lawn and Garden Equipment* [10] demonstrate that equipment operators are exposed (through extended use of garden equipment) to hazardous VOCs emissions from conventional 2-stroke petrol engines. Moreover other data in these QHSS studies (not shown) indicate that the age of mower engine appeared to also have strong effects on level of VOCS emitted from mowers.

2. Marine Engine Equipment
2.1:Introduction
One of the areas of most concern is a figure taken from the 2005 sales of 2-stroke outboard carburettor engines of 63% of sales in Australia. This high level compares to a much lower levels of 30% Europe, 25% Canada & 15% USA. This means that only 37% of outboard engine sales in Australia in 2005 were using low emission technologies.

This discussion paper recognises effects of waterway pollution by two stroke engines but concentrates on ambient air emission from these off road engines. Moreover, it is my view that the effects of waterway pollution by continuing use two stroke (carburettor) marine engines are detrimental to the environment (especially sensitive areas). This together with other emission factors need to be taken into account when new emission regulations are introduced for marine engines
For example paper says on:

- page 3 "---*carburetted two stroke engines can emit up to 30% of their fuel unburned into the* ***water*** ***or*** ***atmosphere****, and these high-emission engines are prohibited on some lakes in California.*
- Page 9 Section 3.2 " *the California Air Resources Board estimates that a carbureted two stroke engine can emit up to25 - 30% of its fuel unburned into the* ***water*** *or* ***atmosphere****, which is why high emission engines are prohibited on some lakes in California (CAL Boating*

2.2:VOC's Ambient Air Emissions
A study done by Martin (1999) [3, 10] found that in one day's use, a single two stroke powered Jet Ski (PWC) will emit the same amount of hydrocarbons and nitrogen dioxide as a 1998 model car that has travelled 160,000 Km

Based on these findings from these studies, the USA EPA has mandated a 75% reduction in oxides of nitrogen (Nox) emissions from these engines two stroke outboard engines and changes to designs were enacted in 2006. Australia has yet to adopt any such a mandate. As a result of this inaction Australia has had a flood of cheap two outboard stroke motors. And given the useable life of a typical outboard engine of 10-20 years, their environmental effects will persist even if Australia adopts mandates similar to USA EPA proposed in 2012—2015. Other studies [4] have shown the hydrocarbon emissions are:

- Detrimental to water quality.
- Detrimental to Marine biota

Consultation RIS Reducing Emissions-Non Road Spark Engines & Equipment
2.3:Environmental effects 2-Stroke marine engines

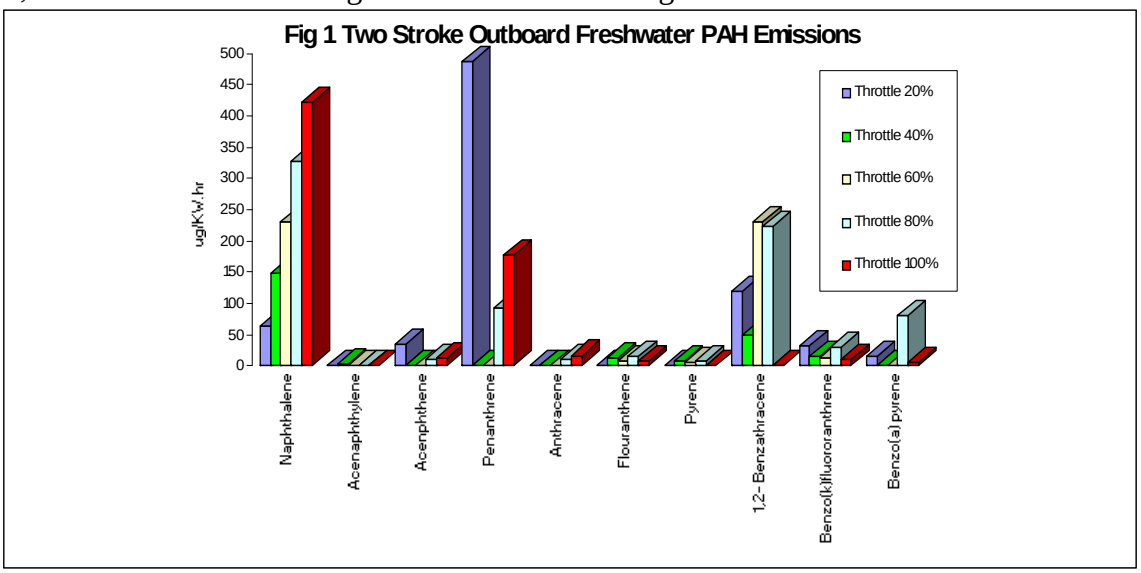
Two stroke engines run on a mixture of motor oil and petrol. These engines are a source of toxic water pollution and have caused serious environmental damage in Inland waters such as Lake Constance in Switzerland[1] and Myall lake system in NSW Australia[2]. Studies cited by U.S. Environmental Protection Agency claim that two-stroke engines, like those used in Jet Skis (PWC) empty 25 percent of their fuel into the water unburnt. Two strokes discharge as much as one third of their fuel and oil unburnt into the water and air. A two-hour ride on a Jet Ski (PWC) can dumps 10 litres of Petrol and oil into the water

The result being that hydrocarbons found in petrol and oil float to the surface of the water and can settle within shallow ecosystems along the shoreline of lakes and rivers, a critical habitat area. Polluting such areas can poison much of the complex food web.

Most recent studies in Australia, CA Kelly et al 2003[5], using a new 1.9W two stroke outboard engine have investigated for the presence of Polycyclic Hydrocarbons (PAH's) and Volatile Organic Compounds (VOC,s) in both fresh and sea water in a typical coastal region Redland Bay S.E. Queensland. These investigations revealed that PAH's & VOC's are major pollutants produced by these two stroke outboard engines.

2.4: PAH's in the marine environment

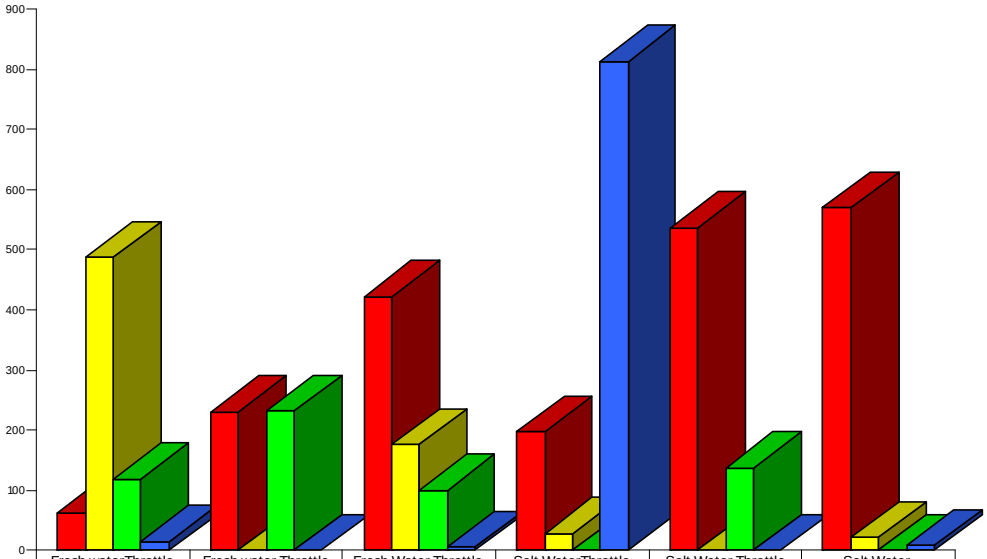
Polycyclic Aromatic Hydrocarbons (PAHs) are a complex class of organic compounds and contains only carbon & hydrogen atoms. Incomplete combustion of organic matter (petrol) releases PAH compounds such as Napthalene, Phenanthrene & Benzo (a) Pyrene. PAH's were found to be a serious water pollutant Baird [6](1999). **PAH,s remains relatively near the point source.** Thus the majority of the PAH,s entering the aquatic environment are localised in rivers, estuaries and coastal marine waters Neff [7] (1979). The low molecular weights PAH, s has been shown to display acute toxicity to aquatic organisms. The larger PAH molecules have been linked to liver lesions and tumours in some fish Baird[6] (1999. Freshwater studies conducted for PAH compounds Kelly [5] (2003) it was found that Naphthalene, Acenanthrene and 1,2-Benzanthracene had high emission rates. See figure 1 below



Source Table 3 Underwater Emissions from Two Stroke Outboard Engines: Can the type of Lubricant Make a Difference? CA Kelly, RJ Brown, GA Ayoko, &W Scott NEC Conference Brisbane 6/2003

Consultation RIS Reducing Emissions-Non Road Spark Engines & Equipment
2.4: PAH's in the marine environment (Cont)
In Seawater studies showed similar trends to fresh water. The emission rates of Napthelene and phenanthrene were significantly higher than other compounds. The emissions of Napthalene were higher at all throttle settings and increases linearly with increases in throttle settings. An exception is the high rate of Benzo (a) Pyrene that was emitted at high rate of 20% throttle settings See Figure 2 below
Source Underwater Emissions from Two Stroke Outboard Engines: Can the type of Lubricant Make a Difference? CA Kelly, RJ

Fig 2 Two Stroke Outboard Salt-Fresh Water PAH Emissions



	Fresh waterThrottle 20%	Fresh water Throttle 60%	Fresh Water Throttle 100%	Salt WaterThrottle 20%	Salt Water Throttle 80%	Salt Water Throttle100%
Naphthalene	63.23	2311	42162	197.45	535.85	569.55
!,2-Benzanthracene	487.66	0	176.65	28.64	0	22.52
Phenanthrene/Anthracene	119.03	23163	100.46	0	137.03	0
Benzo(a) pyrene	14.7	0	6.46	812.96	0	8.72

Brown, GA Ayoko, &W Scott NEC Conference Brisbane 6/2003

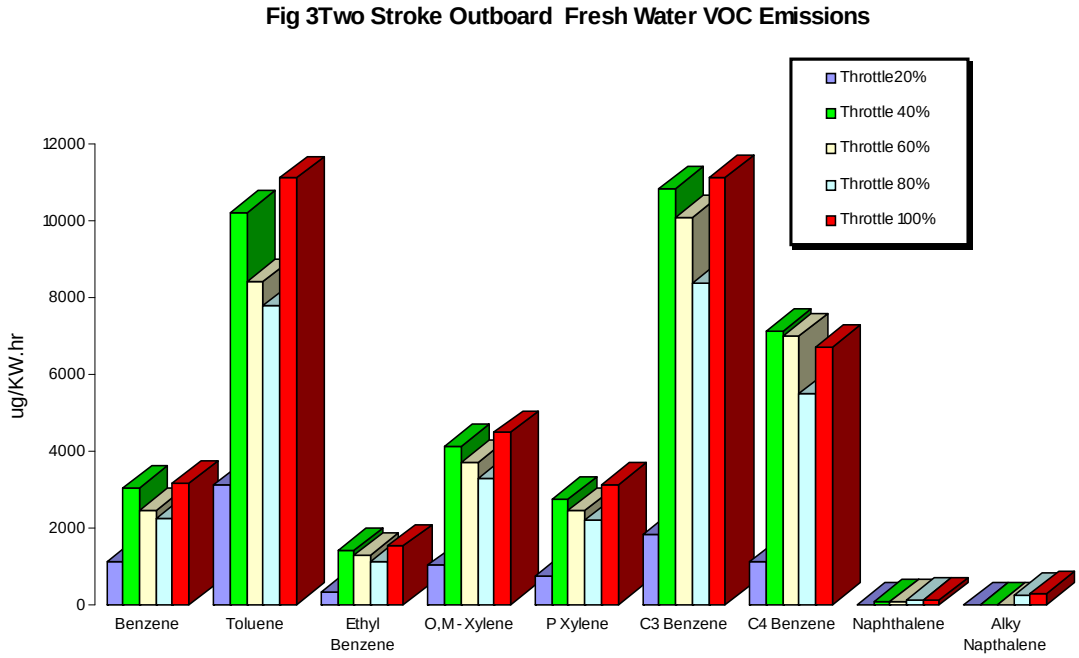
2.5: VOC's in the Environment

Volatile organic compounds (VOC's) can cause adverse human health effects eg Benzene. Two stoke outboard engines are notorious for emitting significant amounts of unburned hydrocarbons (VOC's) into the environment Baird[6] (1999) such as benzene, toluene, Ethylbenzene and Xylene.

The ANZECC (2000)[9] state that VOC's such as toluene & benzene from two stroke outboard motors are not expected to absorb quickly into the environment but do acknowledge their toxic effects are additive.

In Figure 3 below the emission rates of the VOC compounds such as Toluene and C3 Benzene were very high however alkyl Naphthalene's were lower

Consultation RIS Reducing Emissions-Non Road Spark Engines & Equipment
2.5: VOC's in the Environment (Cont)



Source Table 3c Underwater Emissions from Two Stroke Outboard Engines: Can the type of Lubricant Make a Difference? CA Kelly, RJ Brown, GA Ayoko, &W Scott NEC Conference Brisbane 6/2003

3: Dioxins: Non Road Spark Engines & Equipment

3.1:Introduction

The Australian National Dioxins program Studies 2001-2004 (DEH) findings examined sources of dioxins in our environment one of which included transport by emissions from 2 & 4 stroke engines. And since this RIS paper fails to address this matter my submission is intended to inform the Non-Road Engines Working Group that dioxins emissions do count when deciding new regulations for Non Road Spark Engines & Equipment

The Stockholm Convention (2000) on Persistent Organic Compounds (POP's) sets out obligations for countries to reduce POP's, which includes Dioxins. The term "Dioxin" describes a group of toxic organic chemicals that remain in the environment for a long time. Dioxins which are emitted to the atmosphere where they can then be deposited on plants, soil, and sediments in water bodies.

Dioxins can accumulate in the body fat of humans and animals Dioxins concentrate up the food chain so animals have higher concentrations

Dioxins can adversely affect many vertebrate species. At low levels they can disrupt the development of the endocrine, reproductive immune and nervous systems of the offspring of fish birds and mammals.

Consultation RIS Reducing Emissions-Non Road Spark Engines & Equipment
3.2: Dioxin Estimates: 2- 4 Stroke Engines
This RIS paper found many small powered internal combustion engines in Australia that are used today in boats, jet-skis, lawnmowers, chain saws, and other vehicles are powered with inefficient 2- stroke engines. The operation of these 2-stroke engine leads to high released of toxic pollutants and during this combustible processes produce as an unwanted by-product dioxins (PCDD/PCDF)

The range of dioxin emissions presented below is based on the range of activity data estimated for 2-stroke engines and for 4-stroke engines derived from the publication of the National dioxin program[8] *"Dioxins in Australia "*2004 by DEH Australia. Table3 & 4 below presents the dioxin emission estimate for 2 & 4-stroke engine combustion in the transportation sector**.**

Table 3 Estimate of Dioxin Emissions – 2-Stroke Engines

Category	Air emission (g TEQ/a)			Water emission (g TEQ/a)			Land emission (g TEQ/a)		
	L	BE	H	L	BE	H	L	BE	H
2-stroke engines	0.16	0.19	0.23	NA	NA	NA	NA	NA	NA

Source: National Dioxin Program Technical Report #3 Inventory of Dioxin Emissions Australia 2004 page 50 [8]
L = Low Estimate; BE = Best Estimate; H = High Estimate; NA = Not Available

Table 4 Estimate of Dioxin Emissions – 4-Stroke Engines

Category	Air emission (g TEQ/a)			Water emission (g TEQ/a)			Land emission (g TEQ/a)		
	L	BE	H	L	BE	H	L	BE	H
Unleaded fuel without catalyst	0.02	0.1	0.2	NA	NA	NA	NA	NA	NA
Unleaded fuel with catalyst	0.1	0.2	0.3	NA	NA	NA	NA	NA	NA
Total	**0.12**	**0.32**	**0.54**	-	-	-	-	-	-

Source: National Dioxin Program Technical Report #3 Inventory of Dioxin Emissions Australia 2004 Page 49[8]
L = Low Estimate; BE = Best Estimate; H = High Estimate; NA = Not Available

4: Issues not raised in the RIS consultation papers
These are as follows:
1.Regulations for other applications of Small Non-road Equipment: Spark-ignition (SI) engines which are rated below 25 horsepower (19 kW) that such as utility vehicles [quad bikes], generators, and a variety of other construction, farm, and industrial equipment.

2.Regulations to introduce retrofit pollution control equipment measure in these *"in use"* off road 2-stroke carburettor engines as preventative measures to reduce emissions & health issues

3. Regulations to cater for catalyst deterioration in Small Non-road Equipment Spark-ignition engines. Over the lifetime these non-road spark emission engines are impacted to some degree, by time and the engine itself and may leading to increased emission. The engine catalyst can poison by soot build-up and by active surface loss. All appear to be the contributing factors to the deterioration of the catalysts[12]. Refer to paper "*Catalyst Deterioration over the Lifetime of Small Utility Engines"*

Consultation RIS Reducing Emissions-Non Road Spark Engines & Equipment

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10 *Exposure of Operators to Air Pollutants from Lawn and Garden Equipment* http://www.iuappa2007.com/ Shu-huei Huang, Queensland Health Scientific Services (QHSS), Australia

11 *Pilot Study on Lawn Mowers* [Poster] QHSS 2006 gary_golding @health.qld.gov.au

12 *Catalyst Deterioration over the Lifetime of Small Utility Engines* Oct 2007 http://www.awma.org/ Nicholas J. Doll and John R. Reisel, Center for Alternative Fuels, Mechanical Engineering Department, University of Wiscons Milwaukee, Milwaukee, WI

Consultation RIS Reducing Emissions-Non Road Spark Engines & Equipment

Appendix A

Concentrations in Ambient Air [VOC'S ug/m3] while using various garden Equipment

Source: *Exposure of Operators to Air Pollutants from Lawn and Garden Equipment*[10] http://www.iuappa2007.com/ Shu-huei Huang, Queensland Health Scientific Services (QHSS), Australia

Table 1. Concentrations of VOCs (µg/m³) in ambient air while using various garden equipment

Engine Type	2 stroke wippersnipper	2 stroke push mower	4 stroke push mower	4 stroke ride-on mower
Compound (µg/ m³)	Average, N = 2	Average, N = 15	Average, N = 15	Average, N = 6
n-Hexane	84	240	44	19
Ethyl Acetate	3.7	5.4	4.6	1.8
Chloroform	3.5	7.1	9.0	2.8
1,1,1-Trichloroethane	4.0	7.8	8.1	3.7
Benzene	23	82	19	7.4
Trichloroethene	4.2	7.5	10	3.8
n-Heptane	19	64	16	2.4
Methyl cyclohexane	8.2	24	6.9	2.2
Methyl isobutyl ketone	3.7	4.3	6.6	2.7
1,1,2 -Trichloroethane	4.2	8.0	10.8	3.8
Toluene	230	690	120	49
n-Octane	5.2	26	5.0	0.7
Tetrachloroethylene	4.8	7.5	9.2	3.4
Ethyl benzene	37	120	23	6.9
m -& p -Xylene	220	560	120	38
o-Xylene	68	190	37	12
n-Nonane	3.1	5.7	3.6	0.1
1,3,5 - Trimethyl benzene	13	48	10	3.1
1,2,4 - Trimethylbenzene	45	130	20	6.4
n-Decane	0.4	15	2.3	1.6
1,2,3 -Trimethylbenzene	14	34	17	2.6