FINAL REPORT

VOCs from Surface Coatings – Assessment of the Categorisation, VOC Content and Sales Volumes of Coating Products Sold in Australia

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Prepared by:		**Authorised by:**	
Name:	Yvonne Scorgie	Name:	Damon Roddis
Title:	Senior Manager	Title:	Senior Manager
Phone:	(02) 9954 8130	Phone:	(02) 9954 8100
Email:	yscorgie@environcorp.com	Email:	droddis@environcorp.com
Signature:		Signature:	

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Executive Summary

ENVIRON Australia (Pty) Ltd was commissioned by the NEPC Service Corporation, on behalf of the Environment Protection Heritage Council (EPHC) Standing Committee to undertake a project entitled *Volatile Organic Compounds (VOCs) from Surface Coatings – Assessment of the Categorisation, VOC Content and Sales Volumes of Coatings Products Sold in Australia.*

The main study objective was to provide high quality information about coating products, as is required to inform government policy about the feasibility and environmental benefits of undertaking policy actions to reduce VOC emissions from coating products. Given the aim of reducing VOC emissions primarily to limit the potential for adverse environmental and human health effects associated with tropospheric ozone, the ozone creation potential of VOCs released by different product types is also of specific interest.

Key aspects of the project included:

- Inventory and categorisation of surface coating product types manufactured in and imported into Australia.
- Collation of detailed information for coating product types including manufacture and sales volumes, VOC contents and end use of product types.
- Assessment of VOC contents of product types in relation to local and international limits, and identification of potentially significant product types taking into account end use, volumes used and the tropospheric ozone formation potential of VOC emissions.
- Review policy options for reducing VOC emissions, noting technical, economic and other issues related the potential implementation of such options.

The technical consultancy was primarily a desk top scoping study, with all VOC content data being obtained from coating manufacturers and suppliers. Provision was made for checks and balances to identify potentially erroneous data.

Technical and economic issues related to the control of VOCs within surface coating product were primarily identified based on regulatory impact assessments conducted abroad to inform VOC limit setting, and consultation with local industry representatives.

Literature surveys, meetings with trade associations and individual companies, and the distribution of surveys and collation of data were undertaken as part of the study. Detailed 2007 data were available for over 85% of the product categories (by volume), with the exception of Industrial Wood Care (60%).

The data set generated is sufficiently comprehensive and current to support the analysis required to meet the study objective. Industrial Coating information was however only available for production categories rather than by end-use functionality, making it impossible to identify Industrial Coatings that are used within factory applications where VOC emissions can be cost effectively captured and destroyed through source controls.

Product Categories and Types

The product categorisation system selected comprises three levels of classification: (1) Market Segments, (2) Product Categories and (3) Product Types. Market segments, product categories and product types identified for inclusion in the study are outline below.

Market Segment	Product Category	Product Types
Architectural & Decorative	Architectural & Decorative Paints & Enamels	Paving Paint; Roof Paint; Metal finishes; Prepcoats; Door,Window,Trim; Fence finishes; Specialty finishes; "Heavy end" texture coatings; Ceiling Paint/Flat topcoats; Interior topcoats; Exterior topcoats
	Architectural & Decorative Wood care	Decking paint; Flooring; Interior stains; Exterior stains; Prepcoats; Interior clears; Exterior clears
	Architectural & Decorative Thinners	
Industrial	Road & Runway Marking	Road and runway marking coatings (water and solvent borne)
	Other Industrial – Finishing Coats	Alkyd; Polyurethane 2K; Isofree 2K; Epoxy; Baking enamel; Acrylics
	Other Industrial – Primers and Undercoats	Alkyd 1K; Polyurethane 2K; Isofree 2K; Vinyl etch; Epoxy; Acrylics
	Industrial Wood care	Stains; Clears; Solid Colours
	Industrial Thinners	
Automotive	Automotive Refinishing (including thinners)	1K-Primers; 1K-Lacquers-Clear; 1K–Lacquers–Colour; 1K–Synthetic air dry enamels; 1K-Thinners; 2K–Primers–Urethane; 2K–Primers–Others; 2K–Basecoats; 2K–Topcoats–Clears; 2K–Topcoats–Colour; 2K–Hardeners–Isocyanates; 2K–Hardeners–Other; 2K–Thinners; Others (e.g. Cleaners, Enamels)
Heavy Duty	Marine	Antifouling; Foul Release; General; Primer/Surfacer; Single Pack - Protection of Steel; Tie-Coat; Topcoat - Multi Component; Topcoat - One Component; Two Pack Epoxy - Protection of Steel; Two Pack Epoxy Filler; Wash Primer; Zinc Rich; Extreme High Gloss Coating
	Yacht & Leisure Craft	Antifouling; Clear Wood Finish – Sealer; Clear Wood Finish – Varnish; Foul Release; General; Primer/Surfacer; Single Pack - Protection of Steel; Tie-Coat; Topcoat - Multi Component; Topcoat - One Component; Two Pack Epoxy - Protection of Steel; Two Pack Epoxy Filler; Wash Primer; Extreme High Gloss Coating
	Protective Coatings	Intumescent; General; Primer/Surfacer; Single Pack - Protection of Steel; Tie-Coat; Topcoat - Multi Component; Topcoat - One Component; Two Pack Epoxy - Protection of Steel; Two Pack Epoxy Filler; Wash Primer; Zinc Rich
	Others (thinners)	

Product categories *excluded* from the definition of product types and the collation of detailed data, on the basis of their being used in either controlled or potentially controllable environments (termed 'source controllable coatings'), were as follows:

Market Segment:	Product Categories:
Industrial	Can and coil
	Flat board
	Powder coatings (no VOCs)
Automotive	Automotive OEM

Architectural and Decorative coatings are applied to buildings, their trim and fittings, for primarily decorative but potentially also protective purposes. They are applied in situ by professional or private users. Such coatings exclude products applied on factory production lines, coatings used for non-stationary structures, and heavy duty coatings such as structural steel paints.

Within Architectural & Decorative, a distinction is made between Paints & Enamels, and Wood care. The former includes solvent-borne and water-borne coatings including primers, undercoats and finishing coats. Architectural & Decorative Wood care is defined as all products sold for application to interior or exterior timber as a clear or a stain.

The Industrial Market Segment comprises a wide range of diverse product types. Products are often designed for user's specific applications, tailored specifically for the method of application and curing to be used, as well as for the end use of the cured coating.

Industrial coating users include: transport, engineering, construction, furniture, plastics and packaging. Given that information on industrial coatings were only available from paint manufacturers rather than end users, it was not possible to define industrial product categories on the basis of end-use functionality. A distinction was instead made between finishing coats and primers and undercoats.

Automotive refinishing refers to the application of coating products to any motor vehicle subsequent to the initial manufacturing process. Automotive refinishing includes operations in auto repair shops ('smash repairers'), new dealer repair/paint shops, fleet operator repair/paint shops and custom-made car fabrication facilities. Products generally comprise paints (primers, topcoats), lacquers, enamels, adhesives (hardeners) and thinners. A distinction is generally made between one-pack (1K) and two-pack (2K) products. A one-pack coating formulation is applied without a subsequent clear coat. Two-pack systems refer to coatings systems supplied in two parts which must be mixed in the correct proportions before use.

The Heavy Duty Segment comprises Marine, Yacht/Pleasure Craft and Protective Coating Categories. The Protective Coatings market is made up of users who apply protective and anti-corrosive coatings, usually to steel and concrete structures. Most users are highly specialist painting contractors working on structures where the standard of protection required is very high and access is often difficult. Such structures include bridges, heavy industrial plants, offshore drilling rigs and production platforms.

The marine paint market comprises users who apply paint above and below the waterline of ships and boats. The market can be split into sectors based on the size of the vessel being painted, ranging from large passenger, cargo and naval vessels which are international in their movements and need to be dry docked for major painting, to leisure craft, maintained by their owners or by specialist shipyards.

Coating Volumes, VOC Emissions and Ozone Creation Potentials

A summary of the volumes, total VOCs and associated Ozone Formation Potential of surface coatings sold in Australia in 2007, excluding 'source controllable coating' use, is given in **Table 1**.

Architectural & Decorative Coatings account for 75% of the total volume, Industrial Coatings for 13%, Heavy Duty Coatings for 7% and Automotive Refinishing for the remaining 5% of the coating volumes sold (excluding identifiable 'source controllable coatings').

The percentage of low VOC / water-borne coatings sold within Australia within each of the main market segments is as follows: Architectural & Decorative (89.7%), Industrial (45.8%), Automotive (7.9%) and Heavy Duty (0.7%).

If the VOC content of 'source controllable coatings' is excluded, total VOCs were estimated to be 36,466 tonnes. Total ozone formation potential was estimated to be 106,270 tonnes O_3 per annum across all potentially uncontrolled coatings. The ozone formation potential is therefore 2.9 times greater than the total VOC emission estimates.

Table 1: Volumes, total VOCs and associated Ozone Formation Potential of Surface Coatings Sold in Australia (2007), excluding 'source controllable coating' use.

Market Segment:	Product Category:	Volumes (litres)	Total VOCs (tonnes)	Ozone Formation Potential (tonnes)
Architectural & Decorative	Architectural & Decorative Paints & Enamels	141,495,498	9,234	23,491
	Architectural & Decorative Wood care	6,292,002	2,920	7,972
	Architectural & Decorative Thinners	2,698,718	2,699	5,397
Industrial	Road & Runway Marking	4,889,328	406	1,213
	Other Industrial - Finishing Coats	6,021,399	2,876	12,681
	Other Industrial - Primers & Undercoats	9,873,575	2,264	6,595
	Industrial Wood care	4,064,923	2,430	8,091
	Industrial Thinners	2,040,476	2,040	4,897
Automotive	Automotive Refinishing	10,167,024	6,358	20,089
Heavy Duty	Marine	1,011,768	390	1,285
	Yacht	652,785	236	780
	Protective Coatings	9,916,383	2,962	9,801
	PC Thinners	1,650,404	1,651	3,976
TOTAL		**200,774,282**	**36,466**	**106,270**

(a) Represents the volume-weighted average overall product types within the category.

The contribution of Market Segments and Product Categories of total VOCs and Ozone Formation Potentials are illustrated in **Figure 1** and **Figure 2** respectively.

No substantial difference in terms of the relative contributions of Product Categories to the VOC emission and ozone formation potentials of Market Segments are apparent. This is also evident in **Figure 3** which illustrates the percentage contribution of each Product Category to VOC emission and ozone formation potentials of all coatings combined.

Significant Product Categories in terms of total VOCs and ozone formation potential were Architectural & Decorative Paints and Automotive Refinishing. Industrial Finishing Coats, Protective Coatings, Industrial and Decorative Wood Care and Industrial Primers & Undercoats each contributed between 6% and 12% to ozone formation potentials. Marine, Road & Runway Marking and Yacht/Pleasure Craft were noted to have minor contributions.

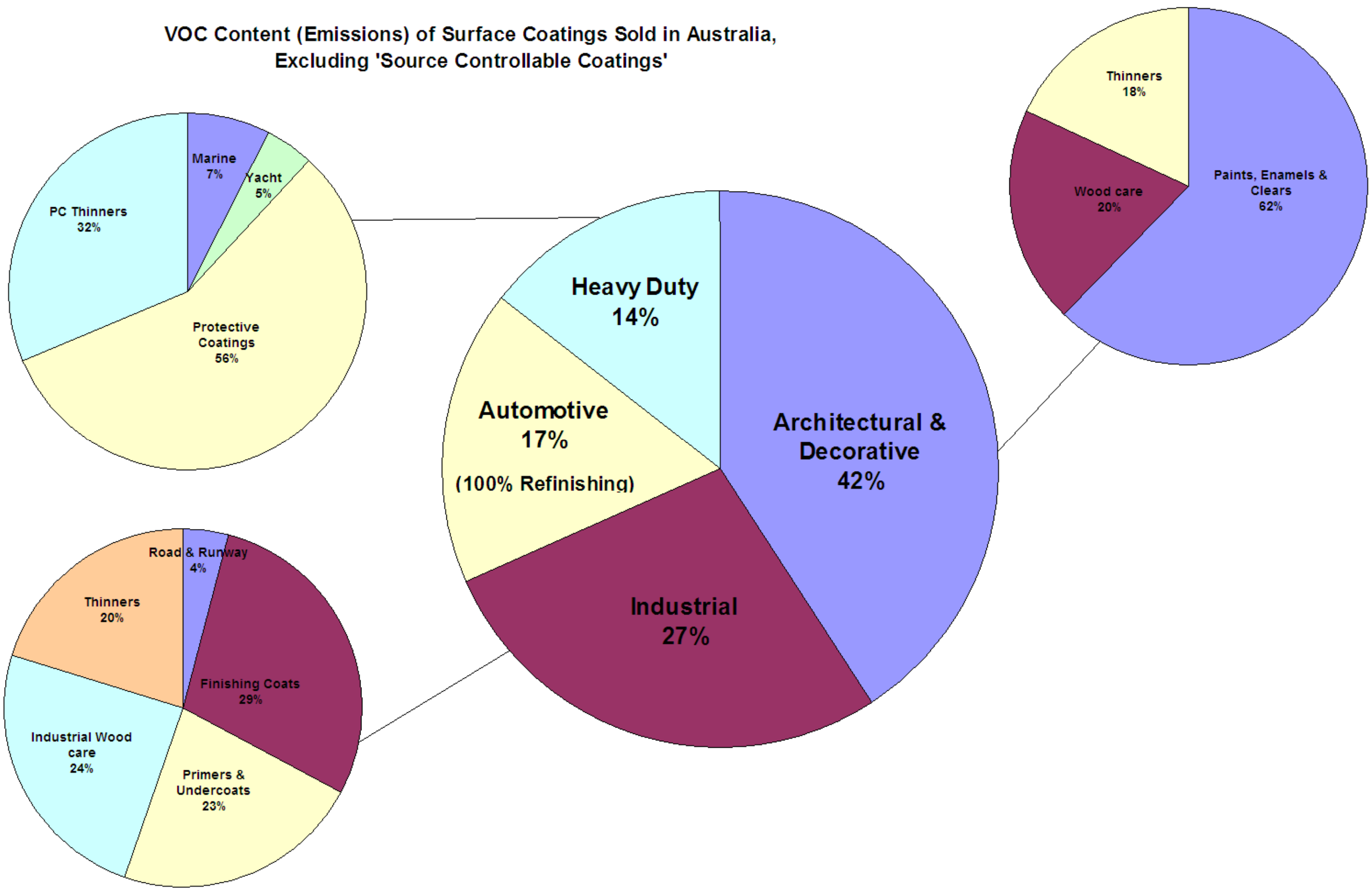

Figure 1: Total VOCs from surface coatings sold in Australia, excluding 'source controllable coatings' (2007).

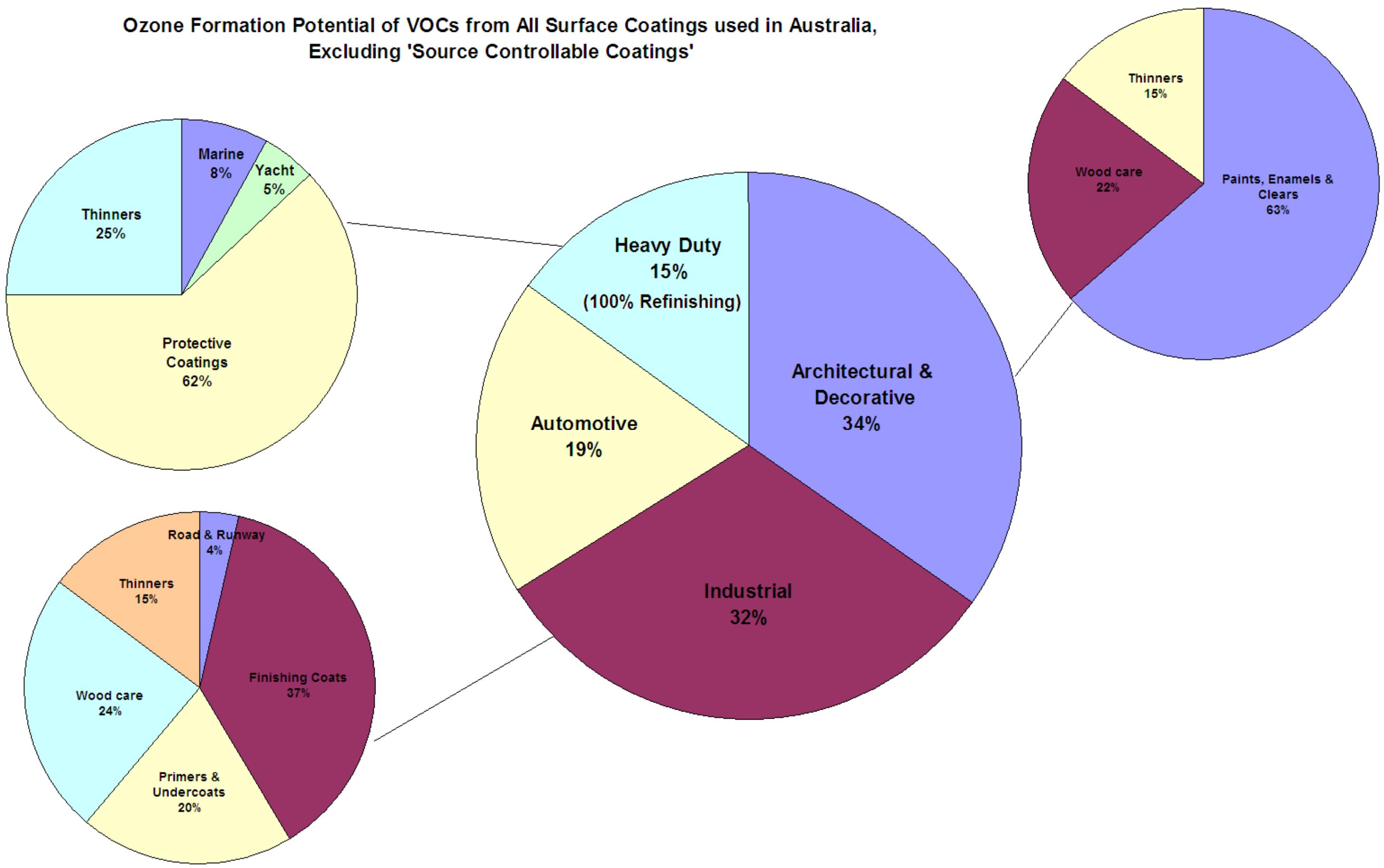

Figure 2: Ozone formation potential of VOCs from surface coatings sold in Australia, excluding 'source controllable coatings' (2007).

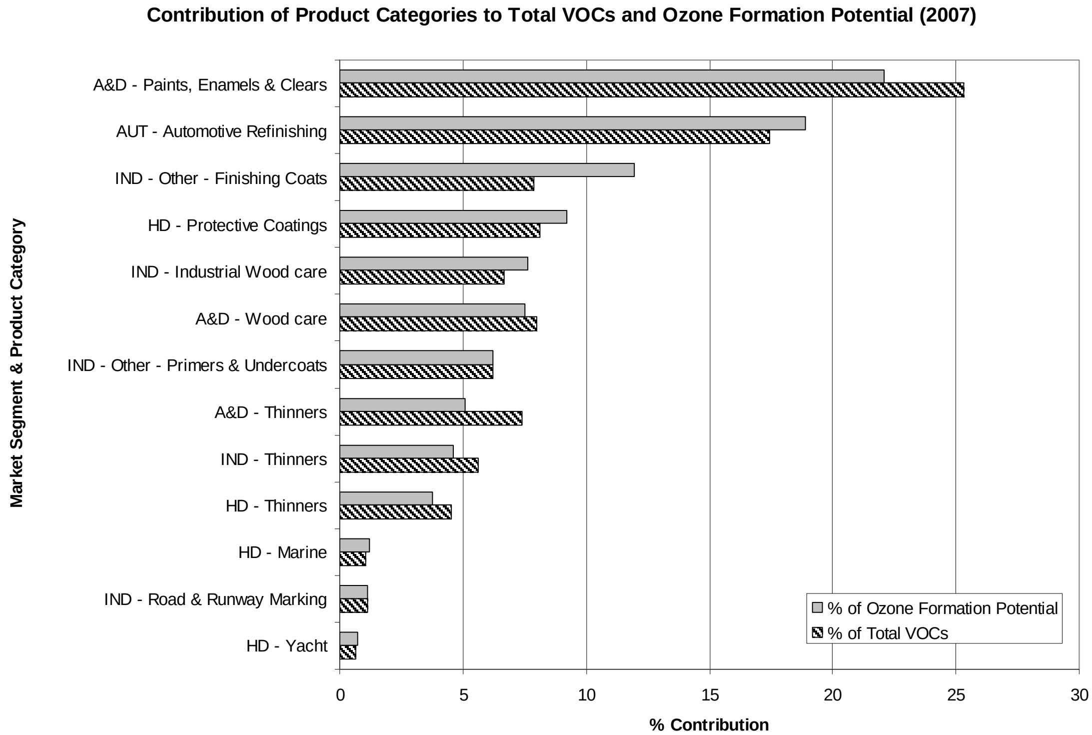

Figure 3: Contribution of Product Categories to total VOC emission and ozone formation potential for the Surface Coating Market (2007)

Contribution of VOCs from Surface Coatings to Total Anthropogenic VOCs

Total anthropogenic VOC emissions are estimated to be about 800 kilo tonnes/annum (NPI, 2007). The potential contribution of surface coating VOCs estimated in this study to total anthropogenic VOC emissions is as follows: Architectural and Decorative (1.9%, conservatively 2.3%), Industrial (1.3%), Automotive Refinishing (0.8%) and Heavy Duty (0.7%); with a combined contribution of 4.7%.

VOC contents estimated during the current study, and hence assumed VOC emissions, were lower than has been estimated in the National Pollutant Inventory (NPI). This is primarily due to differences in coating volume estimates and emission methodologies applied.

Potential VOC and Ozone Formation Reductions Achievable

Reductions in VOC and Ozone Formation Potentials (OFP) which may be achieved given compliance with available local and international VOC limits were estimated, a synopsis of which is given in **Table 2**.

Taking into account contributions to total VOC content and the potential for VOC reductions, Product Categories were identified for potential consideration for VOC control in the short- to medium-term (**Table 3**).

Table 2: Estimated Reduction in VOC Emission and Ozone Formation Potentials given compliance with Local and International VOC Limits

	Total VOC Reduction Achievable (tonnes/annum)			
	Architectural & Decorative Paints/Enamels	Architectural & Decorative Wood care	Automotive Refinishing	Industrial & Protective Coatings
APAS	249	0		39
EU limits – Phase 1 (January 2007)	595	795	2,930	
EU limits – Phase 2 (January 2010)	2,604	1,214		
CARB limits (January 2009)(a)			440 – 1,668	
	Total Ozone Formation Potential Reduction (tonnes/annum)			
	Architectural & Decorative Paints/Enamels	Architectural & Decorative Wood care	Automotive Refinishing	Industrial & Protective Coatings
APAS	631	0		171
EU limits – Phase 1 (January 2007)	1,546	2,169	9,557	
EU limits – Phase 2 (January 2010)	6,719	3,314		
CARB limits (January 2009)(a)			8,118 – 8,606	

APAS – Australian Paint Approvals Scheme; EU – European Union; CARB – California Air Resources Board

(a) Range given to indicate reduction achievable using CARB compliant solvent-borne coatings only (lower reductions) or a combination of CARB compliant solvent- and water-borne coatings

Table 3: Product Categories identified for Potential VOC Control

Market Segment	Product Category:	% of Total Volume of Product	% of Estimated VOC Emissions	% of Estimated Ozone Formation Potentials (OFP)	VOC Control Achievable in Short- to Medium Terms
Architectural & Decorative	Arch & Dec Paints & Enamels	70	25	22	5% to 30%
	Arch & Dec Wood care	3	8	8	25% to 40%
Automotive	Automotive Refinishing	5	17	19	total VOCs, 10% to 60%(a) Ozone formation, >40%
Industrial	Road & Runway Marking	2	1	1	
Total		**81%**	**52%**	**50%**	

(a) The total VOCs range reflects differences in technologies which may be adopted within the regulatory framework selected. Given the US approach, where provision is made for exempt solvents, total VOCs would be reduced in the range of 10% to 30%. Given the EU approach of controlling total VOCs, VOCs reductions of 45% to 50% are expected. Based on information from the literature and local industry experts, VOC reductions from actual smash repair operations using low VOC technologies, were estimated to be of the order of 60%.

Architectural and Decorative accounts for almost 75% of coating volumes used in potentially uncontrolled environments, and about 30% of the VOCs and ozone formation potential (OFP). It is estimated that the VOCs/OFP could be reduced by 10% to 30% in the short- to medium-term (3-5 years), through the implementation of best practice product-based VOC limits. The control of VOCs within this segment may also result in VOC reductions from the use of Architectural & Decorative thinners which accounts for a further 7% of total VOCs.

VOC and OFP reductions to be achieved in the Automotive Refinishing Category are dependent on the regulatory approach to be adopted, with reductions of up to 60% possible. The use of low VOC technologies has also been shown to result in reductions in VOC emissions from other smash repair operations (eg. gun washing) by 50% to 60%.

Despite the small contribution of road and runway marking coatings, these coatings are frequently regulated abroad due to their being used in uncontrolled environments and frequently as part of government commissioned work.

If VOC limits are to be considered for industrial and protective coatings, products specifically designed for end uses such as aerospace, flat board, can and coil, large appliance coatings (etc.) should be made exempt. These coating products are used primarily in large industrial facilities where emissions are typically regulated under license and VOC abatement measures required. Furthermore, life cycle analysis should be undertaken prior to the requirement that low VOC technologies replace high performance coatings used in specialised protective applications.

Marine and Yacht coatings together accounted for only 1% of coating volumes assessed, and 2% of the VOC and ozone formation potentials. Preliminary analysis indicated that limited VOC reductions could be achieved from these coating categories.

Environmental Benefits and Risks of Reducing VOCs

Environmental Benefits

Reduced tropospheric ozone concentrations and associated impacts, such as health risks and damage to materials and crops, represents the targeted environmental benefit of controlling VOC emissions from surface coatings.

Other environmental benefits may include: improvements in indoor air quality, reduced occupational exposures, reduced air quality and odour impacts in the vicinity of coating users (eg. Smash repairers), and lower environmental risks associated with the manufacture of solvents and the disposal of coating containers and waste coatings.

Uncertainties and Potential Adverse Environmental Outcomes

Uncertainties exist regarding the extent of tropospheric ozone reductions which will result due to VOC reductions from surface coatings. A key reason for this is that the location and timing of coatings use and VOC emissions determines actual ozone formation, with such formation also dependent on site-specific factors such as meteorology and topography.

In the case of specialised products where shifts to lower VOC technologies could adversely impact technical performance, increments in VOC emissions could occur in the long term. It is for this reason that life cycle analysis is recommended for high performance products prior to the specification of VOC limits for such products.

Higher environmental risks may also be associated with the increased use of certain substitute (low reactivity) solvents which may be hazardous in terms of other aspects of the environment.

On the basis of regulatory impact studies conducted, governments in North America, Europe and parts of Asia concluded that environmental benefits of limiting VOCs within certain surface coatings products offset adverse environmental impacts. It is notable that benefits and impacts primarily accrue to different parties.

Options for Reduction VOC Emissions

Possible options for reducing VOC emissions from surface coatings include: mandatory product-based VOC regulation; voluntary measures; and market-based instruments such as: emissions trading programs, fees and charges and tax incentives and disincentives.

In Australia various architectural and industrial maintenance coatings are currently limited under the voluntary Australian Paint Approvals Scheme (APAS). This scheme has historically achieved success, encouraging significant VOC reductions within the architectural sector whilst requiring that such reductions not undermine the technical performances of coatings.

A limitation of APAS is that VOC limits selected are primarily decided on by industry representatives. The setting of VOC limits for architectural coatings was historically supported by market changes, with water-borne coatings becoming increasingly more prevalent within this segment. The ability of APAS to set more stringent limits, where such limits would require product reformulations or technology changes not necessitated by market forces, has been questioned. APAS also does not extend to other coating categories such as automotive refinishing.

Automotive refinishing industry representatives in Australia consider it highly unlikely that this sector could be successful controlled under APAS due to the nature of the market. It is held that regulation would be required to force significant technology shifts in the sector.

Market instruments work by encouraging changes in consumer and producer behaviour, and when successfully designed and implemented can promote cost-effective action and provide long-term incentives for pollution reduction and technological innovation. During the course of the study, Australian coating industry representatives requested that tax incentives or other financial benefits be considered for paint manufacturers and others as a means of covering some of the costs associated with moving to lower VOC technologies. Although reference was made to conclusions drawn by international studies regarding the viability of market instruments for realising VOC reductions from surface coatings, the feasibility of applying market instruments locally was not addressed in any detail by the study.

Internationally, product-based VOC regulation has been concluded to be the most effective method of achieving VOC reductions from the use of architectural, automotive refinishing and in certain cases industrial maintenance and marine coatings, when compared to source-based controls, voluntary measures and market instruments.

Technical and Economic Feasibility of VOC Reductions

A review of qualitative technical and contextual information about different product categories was undertaken to assist consideration of policy options to lower VOCs for such categories. Emphasis was placed on the Architectural & Decorative and Automotive Refinishing categories given the potential for VOC reductions identified for these categories.

Automotive Refinishing

The Australian Automotive Refinish market is primarily supplied by global paint companies with major product platforms formulated to meet EU or US regulation. This is important since global companies are likely to have more ready access to existing low-VOC technologies. This was confirmed in discussion with such companies. Low VOC technologies are considered to be readily available for import according to representatives of the major paint companies.

Parties that may potentially be affected by VOC limits include parties that use, supply, sell, manufacture, distribute, blend or repackage for sale any automotive refinishing coatings or associated solvents. Also potentially affected are businesses that manufacture air movement or heating equipment for spray booths, or supply resins, solvents or other ingredients and equipment to automotive refinish coating manufacturers.

Internationally, economic assessments have tended to focus on the impacts on automotive refinishing coating manufacturers and primary users of these coatings, specifically auto refinish shops.

Based on the review of international assessments and knowledge of the Australian market, the following parties identified as being possible at greatest risks due to the introduction of product-based VOC regulations:

- Small and medium-sized manufacturers in Australia which may need to reformulate their products, and/or which may need to produce refinishing products separately for domestic and export markets.

- End-users, specifically smash repairers. Automotive refinishing industry representatives estimated that 60% to 70% of the approximately 4,500 smash repairers operating nationally may be negatively impacted by introduction of product-based VOC controls in the short term (assuming costs are not passed on to customers).

- Global paint companies operating locally may be negatively impacted if Australian-specific regulations resulted in US and/or EU compliant products being excluded.

Architectural Paint and Wood Care Coatings

Significant VOC reduction potentials were estimated to be associated with solvent-borne product types, notably: prepcoats, door/window/trim, metal finishes, and decking paint. With regard to the technical feasibility of achieving reductions, industry representatives were of the view that significant technology improvements would be required to comply with pending EU limits; potentially replacement by water-borne technology which requires a market shift.

VOC reductions realisable through further managing the VOC content of high volume water-borne coatings, such as exterior and interior topcoats, were generally seen by local industry experts as being more feasible.

Certain solvent-borne coatings for specialized applications (eg. stain sealers, penetrating surface binders and metal primers) were identified by industry representatives as critical coating types requiring possible exclusion from product-based VOC controls.

VOC content regulations for aerosol spray packs were perceived by industry representatives as being unjustifiable on the grounds that they comprises only ~1 million litres (3.7 million spray packs), and that cost effective replacement technologies are not available.

Parties potentially impacted by VOC reductions were identified as including:

- Paint manufacturers, with the potential for impacts on the profitability of such companies.
- Coating consumers, including private and professional users.
- Up- and down-stream companies. Companies supplying resins, solvents and other chemical and equipment for use in reformulation of architectural coatings were identified as potentially benefiting, while companies supplying raw material for non-compliant coatings may experience a decline in demand for their products.

Product-based VOC Regulatory Considerations

In the event that mandatory VOC regulation of surface coatings is to be considered, important issues to be taken into account include:

- *Approach to VOC regulation.* Various options exist for the structuring of product-based VOC regulation for the coating sector. Examples include: EU approach of regulating total VOCs; the US approach of controlling VOCs excluding specified 'exempt' solvents which have low ozone forming potentials; reactivity-based VOC regulation, as is implemented in the US for aerosol coatings; acceptance of EU and/or US compliant products; and the combining of two or more approaches.
- *Potential for environmental harm from exempt solvents*. If the US approach is adopted, particular attention will need to be paid to the exemption of low ozone forming solvents as some of these may be toxic or have other associated environmental risks, eg. stratospheric ozone depleting potentials.
- *VOC definition and test method.* The most suitable VOC definition and test method depends largely on the approach adopted. Test methods include actual measurements, involving submission of 'ready for use' product to accredited laboratories for testing, and mass-balance calculation protocols using VOC content information of product ingredients.
- *Broad verses detailed coating categories*. VOC limits may be specified for broad coating categories that make no distinction between general use coatings and niche speciality coatings (EU approach) or detailed coating categories (US approach). Overseas experience can be drawn on to assess the advantages and disadvantages of such approaches.

- *Effective Dates and Transitional Arrangements.* The need for transitional arrangements, specifically lead times for phase in of low VOC products is of note, particularly for market segments with significant proportions of locally produced products such as Architectural and Decorative. A 'sell through period' may be adopted, to provide industry with a reasonable amount of time to market and sell non-compliant coating volumes manufactured prior to the prohibitions applicable to the manufacture and import. The length of this period should be determined in consultation with affected parties.

- *Application of regulations (including exemptions).* Product-based VOC concentration limits are typically applicable to manufactured or imported coatings, but exclude coatings imported or manufactured exclusively for export. Potential exemptions from regulations could include: specific coating types (eg. aerosol coatings), 'small container exemptions', and certain end users (eg. vintage vehicle restorers).

- *Removal of regulatory barriers.* The National industrial Chemicals Notification and Assessment Scheme (NICNAS) process represents a potentially significant hurdle in terms of cost-effective and timely product reformulation.

- *Benefits of global harmonisation of paint regulations.* The need for harmonization of regulations was emphasised by certain Australian paint industries active in global markets, notably industries within the Automotive Refinishing, Protective Coating, Marine and Yacht markets. Benefits of global harmonization were given as including: more speedy adoption of existing low VOC coatings technologies used abroad, ready access to overseas advances in low VOC technologies, and export of locally developed low VOC coatings to EU and US.

- *Need for technical viability studies.* For product types for which the technical viability of switching to lower VOC technologies is uncertain, detailed technology reviews may be necessary to inform regulations. Such reviews may consider: access to low VOC technology and products, regulatory obstacles to introduction of new technologies (NICNAS), phase-in timeframes needed for introduction of new technology, and pack size limitations (if applicable).

- *Need for life cycle analysis for specialised products.* In the case of specialised products where shifts to lower VOC technologies could adversely impact the technical performance of the product (e.g. durability, reduced protection against corrosion), the implementation of life cycle analysis may be necessary.

- *Cost-benefit analyses undertaken as part of the regulatory impact assessment process*. CBA may be necessary for the local manufacturers and users of automotive refinishing products by example. Costs to be taken into account should include: cost from product substitution (including upstream and downstream costs), loss of market share to imports and loss of export markets.

Conclusions

Greatest contributors to VOC emissions

1. Architectural and Decorative Paints and Enamels and Automotive Refinishing contribute significantly to VOCs within surface coating products, followed by various Industrial Coating categories, Protective Coatings and Architectural and Decorative Wood care.

Products with greatest ozone-forming potential

2. No substantial difference was noted in the relative contributions of Product Categories to VOC emission and ozone formation potentials. Architectural and Decorative Paints and Enamels were estimated to have the greatest ozone formation potential, followed by Automotive Refinishing coatings.

Exclusion of controlled emissions

3. Industrial coatings that are usually applied in large facilities where the VOC emissions can cost effectively be captured and destroyed should not be included in any future scheme for product-based regulation of surface coatings.

Products with greatest potential for reductions of ozone-forming potential

4. Product categories that offer the greatest potential for achieving reductions in ozone-forming emissions are Architectural and Decorative Paints, Enamels and Wood care and Automotive Refinishing Coatings. Other categories for which reductions may be achievable are Industrial Wood care and Protective Coatings.

Options for product-based reductions in VOCs from surface coatings

5. Possible options that could be considered as the means of reducing VOC emissions from surface coatings include: mandatory regulation; voluntary measures; and market-based instruments such as: emissions trading programs; fees and charges; and tax incentives and disincentives. Overseas experience can be drawn on if these options are under consideration in the future.

Importance of assessing appropriate means of control

6. The reduction in the VOC content, and related reductions in VOC emissions and ozone formation potentials, of surface coatings in Australia will depend on the nature of any controls that are put in place.

   For example, if Australia follows the EU regulatory approach, then limits would be applied to the total VOC of the ‘ready for use’ surface coating product. If Australia applied the US regulatory approach, then some solvents that are negligible in terms of ozone formation would be exempt with the limits applicable to the remaining VOC content of the coating.

Potential for environmental harm from exempt solvents

7. If the US model is adopted in Australia, particular attention will need to be paid to the exemption of the low ozone forming solvents, as some of these are toxic and car need to be taken not to increase the use of toxic solvents in the community. Furthermore, such potentially exempt solvents may have other negative environmental outcomes, such as stratospheric ozone depletion.

Other important issues to be taken into account in any future controls

8. Architectural and Decorative coatings manufactured in Australia are designed specifically for Australian conditions. Any proposed scheme for controlling VOC emissions would need to take account of Australian conditions.

9. Careful consideration will need to be given to transition into new arrangements to control surface coatings in Australia, providing for phase-in times of any limits and on-selling of discontinued products, to avoid unfair disadvantage for paint manufacturers and importers.

10. For the purposes of controlling surface coatings in Australia, the most suitable VOC definition and test method will depend on the approach adopted. The VOC definition will affect the reductions to be achieved, with the test method selected having cost implications for compliance assessment and demonstration.

11. Consideration needs to be given to the delays in reformulating products for the market arising from the time taken for the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) to assess chemicals that have not previously been approved for use in new formulations.

12. Product-based VOC concentration limits are typically applicable to manufactured or imported coatings, but exclude coatings imported or manufactured exclusively for export.

13. Any scheme for limiting VOC needs to carefully pack size exemptions, with provision potentially being made for ‘small container exemptions’.

Global market for some products

14. The Marine/Yacht and Automotive Refinishing markets are primarily supplied by global paint companies with major product platforms formulated to meet EU or US regulations. Global harmonisation of paint regulations represents a key priority of such global companies operating locally.

15. Global harmonisation of paint regulations would ensure access to global, low-VOC technologies and would also benefit manufacturers of various Industrial and Protective Coatings.

Further assessments required as part of the regulatory impact assessment process

16. Detailed technology reviews may be necessary prior to controlling the VOC contents of product types for which the viability of switching to lower VOC technologies is uncertain.

17. For specialised products where shifts to lower VOC technologies could adversely impact the technical performance of the product, life cycle analysis may be necessary.

18. Cost-benefit analysis is needed for a complete understanding of impacts on coating manufacturers, suppliers and consumers. Such an analysis should consider impacts to upstream and downstream industries of possible product reformulation or substitution.

1 Introduction

The development of national approaches to improve air quality represents a key responsibility of the Environment Protection Heritage Council (EPHC). The EPHC Standing Committee comprises the principal advisory body to the EPHC.

ENVIRON Australia (Pty) Ltd (hereafter "ENVIRON") has been commissioned by the NEPC Service Corporation, on behalf of the EPHC Standing Committee, to undertake a project entitled *Volatile Organic Compounds (VOCs) from Surface Coatings – Assessment of the Categorisation, VOC Content and Sales Volumes of Coatings Products Sold in Australia.*

1.1 Background

Volatile organic compound (VOC) emissions from surface coatings[1] result from the evaporation of solvents (and other organic compounds) in solvent-based and water-based coatings. VOCs originating in coatings contribute to air pollution by evaporating from tanks during manufacture, from applied films during and after drying/curing, and during post-use activities such as clean-up and disposal.

According to the National Pollutant Inventory, architectural coatings alone are estimated to account for approximately 47,000 tonnes of VOC emissions per year on a national basis, representing 6% of national anthropogenic VOC emissions (NPI, 2007). In Sydney, architectural and industrial coatings, including automotive refinishing, were estimated to account for about 13% of anthropogenic VOC emissions. Direct exposure to VOCs emissions can be harmful to human health, especially in poorly ventilated indoor environments[2].

The primary concern underpinning the study is that VOC emissions from surface coatings act as photochemical smog precursors. Ground-level ozone, which is a major component of photochemical smog, is formed in the atmosphere by reactions of VOC and oxides of nitrogen in the presence of sunlight. VOC emissions from surface coating contribute to ozone formation regardless of whether it is applied indoors or outdoors. VOCs continue to be emitted from paints until the product is dry, in some cases this may take several months.

The peak ozone levels experienced by most Australian cities are close to or above the National Environmental Protection Measure (NEPM) standard, with no evidence of a downward trend (DEWHA, 2006). Over the past decade Sydney has, for example, experienced exceedances of ozone standards on between one and 21 days per year. Although some of these exceedances are due to bushfire, it has been established that ozone would still have breached limits at times without bushfire activity (NSW DECC, 2006).

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1 A surface coating is defined as any mixture of film-forming materials plus pigments, solvents, and other additives, which, when applied to a surface and cured or dried, yields a thin film that is functional and often decorative. Surface coatings include paints, drying oils and varnishes, synthetic clear coatings, and other products whose primary function is to protect the surface of an object from the environment. These products can also enhance the aesthetic appeal of an object by accentuating its surface features or even by concealing them from view.
2 VOC exposures can result in eye, nose, throat and skin irritatin, respiratory problems, central nervous system effects, headaches, nausea and lethargy. Although some VOCs are known carcinogens, the industry has voluntarily removed such ingredients from paint formulations.

Exposure to ground-level ozone is associated with a wide variety of human health effects, agricultural crop loss, and damage to forests and ecosystems. Acute health effects due to short-term exposures to ozone include respiratory symptoms, effects on exercise performance, increased airway resistance, increased susceptibility to respiratory infection, increased hospital admissions and emergency room visits, and pulmonary inflammation.

Motor vehicles typically represent the most significant source of smog-precursor pollutants in most cities internationally. In Australia, biogenic emissions contribute very significantly to ozone-forming potentials frequently representing the greatest contributor during wildfire seasons. Other sources of precursors include commercial-domestic sources (including aerosols, solvents and industrial surface coatings) and major industries. Measures being implemented to reduce emissions of ozone precursor pollutants include fuel and vehicle emission standards, regulation of petrol volatility, integrated land-use and transport planning and the regulation of industrial releases.

The application of some surface coatings takes place within controlled environments, where VOC abatement measures are implemented to limit air emissions (e.g. vehicle manufacturing plants). Due however to most surface coating applications being fragmented and widely distributed in nature with small batches being applied, it is usually not feasible to capture and control VOC emissions at the point of use.

Internationally, the trend has been increasingly towards a system of regulation that encourages or requires product reformulation to meet VOC limits for specific coating products. VOC limits for surface coating products are being implemented in the United States, Europe and Hong Kong, and are proposed for adoption in Canada.

Australian coatings manufacturers have been voluntarily reducing VOC levels in certain of their product ranges over the past 15 to 20 years. This voluntary reduction is currently included into the Australian Paint Approvals Scheme (APAS), a government based, voluntary performance specification scheme.

Despite certain VOC emission reductions been achieved through the voluntary measures, questions have been raised regarding the current level of compliance with the APAS limits, the sufficiency of voluntary limits in successfully managing current and future total VOC emissions from the surface coating sector, and the need for and nature of future policies and programs.

1.2 Study Objective

The overall objective of the study is to provide high quality quantitative and qualitative information about individual coating products and product categories that can inform government policy about the feasibility and environmental benefits of undertaking specific policy actions to reduce VOC emissions from individual coating products and product categories. Given that the aim of reducing VOC emissions is primarily to limit the potential for adverse environmental and human health effects associated with the formation of tropospheric ozone, the ozone creation potential of VOC released by different product types is also of specific interest.

Key aspects of the project include:

- Inventory and categorisation of surface coating products manufactured in and imported into Australia.
- Collation of detailed information for coating product types including manufacture and sales volumes, VOC contents and end use of product types.
- Assessment of VOC contents of product types in relation to local and international limits, and identify potentially significant product types taking into account end use, volumes used and the tropospheric ozone formation potential of VOC emissions.
- Review policy options for reducing VOC emissions, noting technical, economic and other issues related the potential implementation of such options for specific product types.

Critical outcomes of the study comprise the identification of:

- The best (most effective, including cost-effective, and technically viable) options for reducing VOC emissions from coatings.
- Products or product lines to be targeted to achieve the greatest overall VOC reductions.

1.3 Scope of Study

The initial scope of study required the inventory of coating products and their grouping into product categories, with categorisation reflecting end-use functionality and, to the extent possible, being consistent with existing APAS and/or overseas categories for coating products. From the onset of the project it was evident that the accessibility and nature of available data on surface coating products from product manufacturers and importers had important implications for the approach required to meet the main study objective.

Following consultation with companies responsible for the bulk of locally sold products it was evident that detailed production, sales, import and VOC content information would not be available for individual products. Furthermore that the product categories for which data could be made available within the timeframe of the project was restricted by existing categorisations for production and sales data reporting for the sector and classification systems used internally by companies.

The data available to inform the study had implications in terms of certain of the project deliverables and required the study approach to be adapted to ensure delivery of the main study objective. The limitations placed on delivery of the required project outcomes were comprehensively documented in the Interim Report (Environ, September 2008).

Despite information not being available on an individual product or company-specific basis, the method of analysing data was adopted to meet the main study objectives. The available data provided the basis for indicating the VOC content ranges, and volume-weighted VOC content, for different product categories. Such VOC contents could then be compared to local and internationally published VOC limits. By assessing the difference between the volume-weighted average VOC contents of locally sold product categories and specific VOC limits, the potential for emission reductions (in tonnes of VOCs) achievable by meeting such limits could be estimated.

Product types of importance in terms of VOC content could be identified, with specific emphasis on product types with uncontrolled end uses and high reactivity-weighted VOC contents. Product types, such as specialist products or products linking to global markets, which may require more detailed consideration, life cycle analysis and/or potential exemptions from VOC limits, were also identified.

It should be noted that the technical consultancy comprised primarily a desk top scoping study. No analyses of coating products were undertaken by ENVIRON, with all VOC content data being obtained from coating manufacturers and suppliers. Provision was however made for various checks and balances to identify potentially erroneous data, e.g. comparisons with published VOC contents, consultation with industry representatives and comparisons across companies.

The identification of technical and economic issues related to the regulation of the VOC content of surface coating product was primarily based on regulatory impact assessments conducted abroad to inform VOC limit setting, and consultation with industry representatives.

The complexity of striking a balance between short-term environmental benefits due to initial VOC emission reductions and potential long-term costs should low VOC coatings not provide equivalent substrate protection and durability is acknowledged. Although the study scope did not include life cycle assessment (LCA), reference was made to pertinent LCAs conducted in respect of certain surface coating product categories.

1.4 Report Outline

The study comprised literature surveys, meetings with trade associations and individual companies, and the distribution of surveys as documented in **Section 2**.

An overview of the Australian surface coatings market is provided in **Section 3**, with information provided on key market segments and industry players, general trends in production, sales and exports and technological and other developments pertinent to the project.

Coating product categories are outlined and described in **Section 4**, with the VOC emission and ozone creation potentials calculated for such categories presented in **Section 5**.

Section 6 documents findings from the comparison of calculated VOC contents with applicable local and international VOC limits. Estimations of potential VOC emission and ozone creation reductions achievable, given compliance with limits, are considered.

The potential environmental benefits and risks associated with controlling the VOC content of surface coatings is assessed in **Section 7**, and potential product types to be targeted considered.

The technical and economic feasibility of implementing VOC limits for significant surface coating product ranges are considered in **Section 8**.

Factors to be considered and addressed in the implementation of product-based VOC limits are documented in **Section 9**.

2 Study Methods

Literature surveys, meetings with trade associations and individual companies, and the distribution of surveys and collation of data were undertaken as part of the study.

2.1 Literature and Existing Datasets

An extensive survey of the literature was undertaken to inform the study and reference made to market studies and trade association databases. The most pertinent sources of information and data were as follows:

- Informark Pty Ltd Sales Data given for Architectural & Decorative Paints, Enamels and Wood care. Informark collates sales data on a quarterly basis from the four main paint companies (Wattyl, PPG, Dulux/Orica and Akzo Nobel) (2007 data used).
- Inter Company Comparison (ICC) Centre Quarterly Industrial Sales Data collated on behalf of the Australian Paint Manufacturers Federation (APMF) (2007 data used).
- Detailed Automotive Refinishing Production Data, given for a breakdown of coating product types, available from the APMF (2007 data used).
- Production Data for the Architectural and Decorative, Automotive, Other Industrial, Heavy Duty Coatings and Timber Finishes market segments, collated by the ICC on behalf of the APMF (2007 data used).
- Historical annual Paint Production Data by market segment for the 1990 to 2007 period, available from the APMF.
- Coating import and export data from the Australian Bureau of Statistics (2007 data used).
- IBIS World (2008). Paint manufacturing in Australia, IBIS World Industry Report no. C2542, 29 may 2008.
- So-called European “Decopaint Study”. EC DG Environment Consultancy Report entitled Study on the Potential for Reducing Emissions of Volatile Organic Compounds (VOC) due to the Use of Decorative paints and Varnishes for Professional and non-professional Use, June 2000.
- Entec (2000), Reducing VOC Emissions from the Vehicle Refinishing Sector, Final Report compiled on behalf of the European Commission by Entec UK Limited and The Paint Research Association, August 2000.
- NSW DECC (2007), Background Paper: EPHSC Investigation of Options to Reduce VOC Emissions from Decorative paints, Prepared by the Department of Environment and Climate Change (NSW).
- Written industry inputs received from Don Dennis of Mirotone.
- Various research study reports commissioned by the California Air Resources Board (CARB) covering the quantification and control of VOC emissions from coatings.
- Australian Paint Approval Scheme (APAS), Document D181, Volatile Organic Compounds (VOC) Limits, 8 December.

- Good Environmental Choice Australia Ltd Australian Ecolabel program, Architectural and Protective Coatings, Standard GECA 23-2005, March 2006.
- European Directive 2004/42/CE on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC, 21 April 2004.
- Canadian Department of Environment, Proposed Volatile Organic Compound (VOC) concentration limits for architectural coatings regulations, 26 April 2008.
- Hong Kong Environmental Protection Department (EPD), Air Pollution Control (Volatile Organic Compounds) Regulation, 2007.
- Hong Kong Environmental Protection Department, Proposal for Control of Volatile Organic Compound Emissions from Vehicle Refinishing Paints, Marine Vessel Paints and Pleasure Craft, May 2008.
- California Air Resources Board (CARB), Suggested Control Measures (SCM), set 2000 and amended 2007.
- United States Environmental Protection Agency (EPA), architectural coatings rule 63 FR 176:48848, adopted 1998 and last amended 1999.
- US-EPA, Source Federal Register, Updated 7/24/03, Subpart B – National volatile organic compound emission standards for automobile refinishing coatings.
- US-EPA National Volatile Organic Compound Emission Standards for Aerosol Coatings (aerosol spray paints), 2007.
- CARB Regulation for Reducing the Ozone formed from Aerosol Coating Product Emissions, 2007.

2.2 Product Categorisation for Data Collation Purposes

The initial scope of study required the inventory of coating products and their grouping into product categories, with categorisation reflecting end-use functionality and, to the extent possible, being consistent with existing APAS and/or overseas categories for coating products.

In preparation for the product categorisation and data collection phase, a review was undertaken of the surface coating product categories specified locally and internationally for the purpose of specifying VOC limits. Product categorisations inventoried included those outlined in the aforementioned existing and proposed VOC regulations.

Significant differences in the market segment coverage and level of detail was noted across the various local and international product classification systems. Whereas the EU and APAS product categories are more general, detailed classification systems are specified by the US-EPA, CARB, Canadian EPA and Hong Kong EPD as indicated by the numbers of categories for which provision are made.

Following consultation with members of the Australian Paint Manufacturers Federation (APMF) and the Inter-company Comparison Centre (ICC) it became apparent that product categorisation for data collation purposes would need to be based on existing product classifications used for the inventory and reporting of production and sales data. This was necessary in order to gain the cooperation of companies in the submission of their data and to facilitate data collation within a reasonable timeframe.

Product classification systems which are used locally to inventory, report and compare data across the surface coating sector are as follows:

- Informark Pty Ltd Sales Categories given for Architectural & Decorative Paints, Enamels and Wood care. Informark collates sales data on a quarterly basis from the four main paint companies (Wattyl, PPG, Dulux/Orica and Akzo Nobel) using these categories (**Table 1**).
- Inter Company Comparison (ICC) Centre Quarterly Industrial Sales Statistic Survey categories (**Table 5**).
- ICC categories for the collection of Production Data for the Architectural and Decorative, Automotive, Other Industrial, Heavy Duty Coatings and Timber Finishes segments (**Table 6**).

The decision was taken to adopt a tiered approach to data collation comprising:

- Phase 1, the inventory of sales, production and importation volumes and VOC content data as per the Informark and ICC product categories; and
- Phase 2, the collation of more detailed data for a subset of product categories with focus on market segments expected to be of interest (based analysis of the Phase 1 data and the review of international experience), with data submission confined to key players within those markets.

An overview of the Surveys undertaken for Phases 1 and 2 is given in subsequent sections.

Table 4: Informark Pty Ltd Sales Categories

Product Classification System	Market Segment	Product Type
Informark Pty Sales Categories	Architectural & Decorative Paints & Enamels	Paving Paint: solvent-based
		Paving Paint: water-based
		Roof Paint: solvent-based
		Roof Paint: water-based
		Fence finishes
		Specialty finishes
		"Heavy end" texture coatings
		Metal finishes
		Spray packs
		Prepcoats: water-based
		Prepcoats: solvent-based
		Ceiling Paint/Flat topcoats
		Door,Window,Trim: water-based
		Door,Window,Trim: solvent-based
		Interior topcoats: water-based
		Exterior topcoats: solvent-based
		Other
	Architectural & Decorative Wood care	Decking Paint: water-based
		Decking Paint: solvent-based
		Flooring: water-based
		Flooring: solvent-based
		Interior Stains: water-based
		Interior Stains: solvent-based
		Exterior Stains: water-based
		Exterior Stains: solvent-based
		Prepcoats: water-based
		Prepcoats: solvent-based
		Interior clears: water-based
		Interior clears: solvent-based
		Exterior clears: water-based
		Exterior clears: solvent based

Table 5: Inter-company Comparison Centre Industrial Sales Categories

Product Classification System	Market Segment	Product Type
ICC Sales Categories	Industrial (including automotive, protective coatings, marine and industrial wood care)	Automotive - OEM
		Primers and undercoats
		Topcoats
		Automotive - Car Refinish
		Primers and undercoats
		Topcoats
		Heavy Duty Coatings
		Protective Coatings (see notes)
		Marine Coatings (see notes)
		Other Industrial
		Primers and undercoats
		Finishing coats - Nitrocellulose lacquers
		Finishing coats - Other
		Road & Runway marking
		Can and Coil
		Flat Board Coatings
		Powder Coatings
		Other
		Thinners
		Thinners - for nitro cellulose coatings
		Thinners - for all other coatings
		Industrial Wood care (see notes)
		Stains
		Clears
		Solid Colours

Table 6: Inter-company Comparison Centre Production Categories

Product Classification System	Market Segment	Product Type
ICC Production Categories	A & D Paints, Enamels & Clears	Solvent thinned
		Water thinned
		Thinners for A & D paints, enamels & clears
	Automotive	Automotive
		Automotive thinners
	Other Industrial Points, Enamels & Clears	Fast dry alkyd topcoats and primers
		Nitrocellulose lacquers
		Other industrial
		Thinners
	Heavy Duty Coatings	Two pack products
		Single pack products
		Zinc rich products
		Marine coatings
		Road marking paint
		Thinners
	Timber Finishes (Excluding Wood Preservatives)	A & D timber finishes
		Industrial finishes
		Floor finishes

2.3 Phase 1 – Preliminary Data Collation

The Phase 1 (Preliminary) Survey compiled by ENVIRON in consultation with various industry representatives is given in **Appendix 1**. This Survey comprised the collation of the following data:

- Production Data - Volumes of surface coating products manufactured within Australia, and information on the total VOC content of such product categories, with specific reference to existing Inter Company Comparison (ICC) Centre production categories to expedite information submission. Paint manufacturers report their production figures to the ICC using these categories, with statistics being periodically published by the APMF. By making reference to such statistics it was possible to determine the completeness of information received for the survey.)
- Sales Data – Volumes and VOC contents of surface coating products sold within and exported from Australia. Data for the Architectural & Decorative Paints, Enamels and Wood care categories were collated for the existing Informark Pty Ltd categories, except that certain of the categories were expressed separately for water- and solvent-based. Data for industry categories were requested for the ICC Quarterly Industrial Sales Statistic Survey categories.
- Import Data – Volumes and VOC contents per product category was requested for all imported products, with information on total imports and imports by country of origin requested.

- Solvent Usage – Volumes and VOC reactivity (as available) of solvents used by surface coating product manufacturers during 2007 was requested. Data were requested as total solvent volumes, with an indication of the volumes used to produce specific manufacturer-defined classes of product.

Drafts of the Phase 1 Survey was circulated among industry representatives during July 2008 with a view to gaining consensus on the scope of the survey, preparing companies for data submission and establishing working relationships with industry representatives.

The final Phase 1 Survey was circulated on 6th August 2008. With the cooperation of the APMF the survey was circulated to the following companies: Dulux (Orica), Wattyl, BASF Coatings, Haymes paint, Concept Paints, Akzo Nobel, PPG, Valspar, Sherwood Paints, Viponds Paints, Lacnam Paints, Bayer Material Science, ACOHS, Paintec, Nynas, Brinlay paints, Bizfine, Cameloen, Protec, DIC Graphics, Colormaker, Marineware, Hempels Marine Paints, Mirotone, Murobond Coarings, Viscount Plastics, Jotun, Lanxes, Tronox, Parr Paints, Wagon Paints, APCO Coatings, Flint Group, Sericol, Nuplex, Supalux, Thor Chemicals, ITW Polymers & Fluids, Bondall, Chem Collect, Fluid Management, Shieldcoat, Millenium Inorganic Chemicals, Astec Paints, Duha Group, De Beer, Schenecttady, DY-Mark, Masterbrand Paints, Krysler Paint. The survey was also sent to Bunnings and Mitre 10 approached for information.

Data was submitted by companies directly to the ICC, with the ICC tasked with collating and aggregating company specific data to ensure confidentiality, and providing the aggregated sales, production, solvent usage and import data to ENVIRON for analysis.

The Phase 1 Survey was concluded at the end of August 2008 with no data subsequently received. These data were rapidly analysed to inform Focus Group meetings held with industry representatives during the week of 1st September 2008.

2.4 Phase 1 Data Analysis

Due to the process followed for data collation a good response was received with 80% of total production and sales volumes being accounted for. A large proportion of the outstanding information was due to both sales/production volumes and VOC content data not being provided by respondents thus necessitating the exclusion of their data from the aggregates. More information on the production, sales and solvent information collected is given below.

2.4.1 Production Data

Nine companies submitted production data, one of which provided VOC information but no product volumes. Data was only aggregated for datasets comprising both product volumes and VOC information.

The total product volumes inventoried was 186,743,599 litres, comprising 84.7% of total production of 220,354,733 litres reported by APMF for the 2007 calendar year. Data coverage by product segment was as follows:

Production Segment	**% Coverage**
A & D Paints, Enamels & Clears	90.0
Automotive	96.5
Other Industrial Points, Enamels & Clears	68.6
Heavy Duty Coatings	86.3
Timber Finishes (Excluding Wood Preservatives)	66.3
Total All products	**84.7**

Total VOC content was surveyed across product segments as being 36,599,328 kg (~20% of production volumes).

2.4.2 Sales Data

Seven companies submitted data, one of which provided VOC but no sales volume data and was therefore excluded. Aggregated data for both Architectural & Decorative and Industrial coatings was therefore based on figures from six companies. Two companies provided a dissection of sales by state.

The total sales volumes inventoried was 196,028,182 litres, representing 86% of the total 2007 volumes recorded by Informark and ICC surveys (228,297,811 litres). It is however noted that Informark survey only collects architectural and decorative sales data from the largest four manufacturers. Data coverage by sales segment was as follows:

Sales Segment	**% Coverage**
Architectural & Decorative Wood care (2007)	111% of previously surveyed Informark totals(a)
Architectural & Decorative Paints, Enamels & Clears (2007)	87% of previously surveyed Informark totals(a)
Industrial sales (2007) (ICC)	96% of previous ICC survey

Notes:
(a) Informark survey only collects architectural and decorative sales data from the largest four manufacturers

Only 1,781,375 litres were reported as exports (i.e. only 9.25% of 2007 exports reported by ABS).

Total VOC content across all local sales products was reported to be 42,814,080 kg (~22% of sales volumes).

2.4.3 Solvent Information

Twelve companies provided solvent information, ten of which provided solvent types, volumes and kg VOCs and were used in the aggregated figures.

107 solvents were reported on - 34,097,705 litres of solvent (15.5% of total production volumes) comprising 30,085,322 kg VOCs (65% of VOCs associated with total production figures).

The solvent information collected was concluded to be insufficiently complete and accurate to facilitate the relative contribution of product categories to reactivity-weighted VOCs.

2.4.4 Data Accuracy

A synopsis of the data collected during Phase 1 is given in **Appendix 2**. Observations and comments made in respect of the data and questions raised at the focus group meetings regarding potential errors in the data are noted in the tables below.

Questions were raised in respect of the accuracy of average VOC concentrations calculated for certain of the Architectural & Decorative and Architectural & Decorative wood care product categories on the basis of the Production and Sales Data surveyed. Such comments were as follows:

- The average VOC content for solvent thinned Architectural & Decorative paints (236 g/L), calculated based on the production data reported, appears to be too low and should be subject to further scrutiny during subsequent data collation.
- The average VOC content for solvent-borne roof paint (291 g/L), calculated based on the sales data, seems too low and should be around 400 g/L.
- The average VOC content for water-based prepcoats (6 g/L), calculated based on the Architectural & Decorative Wood care sales data, appears too low and should be around 50 g/L.
- The average VOC content for solvent-based interior clears (601 g/L), calculated based on the Architectural & Decorative Wood care sales data, appears too high and should be around 450 g/L.

To address the potential inaccuracies in the data inventoried, the average VOC content was requested from the ICC on a company-by-company basis, with company identity masked as required. The company-specific average VOC contents were compared for product categories and significant variations which could account for the skewing of the averaged contents across companies noted. Based on this analysis, corrections in the average VOC contents were made for further consideration in the study.

2.5 Industry Focus Group Meetings

Four Focus Group Meetings were held during the first week of September at ENVIRON's North Sydney Offices, as follows:

- Industrial Focus Group - 2 September 2008 (morning)
- Automotive Focus Group - 2 September 2008 (afternoon)
- Architectural & Decorative Focus Group - 3 September 2008 (morning)
- Marine & Protective Focus Group - 3 September 2008 (afternoon)

The main objectives of the Focus Group Meetings were as follows:

(a) Review of preliminary data collected for the sector and identification of potential errors in the data.

(b) Preliminary assessment of the significance of the various coatings sectors and, information permitting, of individual product types within such sectors, in terms of potential VOC emissions – taking into account:
- End use functionality (e.g. use within large industry with VOC abatement controls or use within dispersed uncontrolled activities)
- Contribution of the sector (product type) to total VOCs contained within inventoried coating products
- Tropospheric ozone formation potential (reactivity) of solvents used in product types. (This objective could not be met during the focus group meeting due to adequate data not being available at that time.)

(c) Identification of general, sector-specific and potential product range issues associated with the implementation of VOC content restrictions. This included technical and economic issues related to product manufacture, upstream raw material supply and downstream usage.

(d) Consideration of various approaches to the regulation of VOC content of coating products, including issues related to:
- VOC definition
- Manner in which VOC limit is expressed
- Categories for which limits are given
- Methods for VOC content quantification

(e) Identification of additional data requirements for specific product ranges to further inform the study and obtain consensus on method and timeframe for the submission and aggregation of this data.

The names of persons having participated in the various focus group meetings is given in **Appendix 3**.

The Focus Group meetings provided the basis for the selection of more detailed product categories for selected market segments for the collation of data as part of the Phase 2 Survey as described in the subsequent subsection.

Various issues related to product-based VOC content regulation within the surface coatings industry were raised during the Focus Group meetings and were inventoried for inclusion in the study.

2.5.1 Phase 2 – Detailed data Collation

The main purpose of the Phase 2 Survey was to collect volumes, total VOC content data and individual solvent content for the main product types for market segments of potential interest in terms of product-based VOC control.

The collection of volumes of individual solvents was necessary to permit the estimation of the reactivity (ozone forming potential) of the VOC emissions associated with such product types. Due to the level of detail required and the short timeframe for data collation, attention was focused on acquiring data for the major players within each market segment.

The Phase 2 Survey was circulated shortly following the Focus Group meetings (**Appendix 4**) with data submission to the ICC for collation and aggregation across companies.

Due to the nature and complexity of the reactivity calculations it became apparent that the analysis had to be done on a company-by-company basis by suitably qualified ENVIRON personnel. It was therefore necessary to negotiate with the industry data providers for release of the individual datasets by the ICC to ENVIRON.

Agreement was reached with the following provisions: (i) the ICC would remove company names prior to sending the individual data sets to ENVIRON; and (ii) that following completion of the study, ENVIRON would delete the individual company datasets, retaining only the aggregated data and descriptions on inter-company variations. ENVIRON and the ICC signed confidentiality agreements to this effect. All Phase 2 data sets were received and approved for use by the end of October 2008.

Further information on the product categories identified for detailed data collation and the companies cooperating in the provision of such data is provided in **Section 4**. The Phase 2 data provided the basis for the study and is comprehensively documented in subsequent sections of the report.

3 The Australian Surface Coatings Market

3.1 Market Segments and Size

The surface coating industry comprises the manufacture, import and export of various paints, timber finishes and other surface coating products for the decoration and protection of surfaces against wear, weather and corrosion. Key products include paints, enamels, varnishes, lacquers and stains. Other products associated with this industry include fillers, as well as prepared paint thinners and removers and prepared tinting colours. Industry products are sold to the household segment as well as to trades people, master painters and industry, including automotive and packaging industries.

Raw materials used for production, such as resins, inorganic and organic dyes, pigments and chemical colours, solvent and additives are sourced from other chemical industries, indicating a high level of interdependence between paint manufacturers and raw material suppliers.

Surface coating market segment classifications typically distinguish primarily between Architectural & Decorative and Industrial markets. The main market segments are defined by the Australian Paint Manufacturer's Federation (APMF) for the purposes of collating and publishing production and sales data as follows (APMF, 2008):

- Architectural and decorative paints and enamels
- Industrial paints, enamels and clears (including automotive, can and coil and flat board)
- Thinners
- Heavy duty coatings (including protective coatings, marine coatings and road marking paint)
- Timber finishes (excluding wood preservatives; including architectural and decorative timber finishes, industrial finishes and floor finishes)

During 2006-07, the paint manufacturing industry generated revenues of $2,455 million. Domestic demand (revenue plus imports less exports) was estimated to be $2,560.6 million, with imports representing 9.04% of domestic demand and exports 5.13% of revenue. The value of imports ($231.5 million) was almost double that of exports ($125.9 million). The industry comprises approximately 90 enterprises, employing 5,900 people, with 0.22 billion litres per annum being produced (IBISWORLD, 2008).

3.1.1 Paint Manufacture

Paint production increased from ~0.2 billion litres to 0.22 billion litres between 1990 and 2007 (**Figure 4**). Architectural & Decorative has remained the largest market segment, followed by Industrial Paints (including automotive, can and coil, flat board and other) remaining the second largest segment. Architectural & Decorative grew from 49% to 57% of production volumes between 1990 and 2007. Industrial Paints reduced as a percentage of production volumes from 30% in 1990 to 24% in 2007. Heavy Duty Coatings increased from 6% to 9% and Timber Finishes from 1% to 4% during this period.

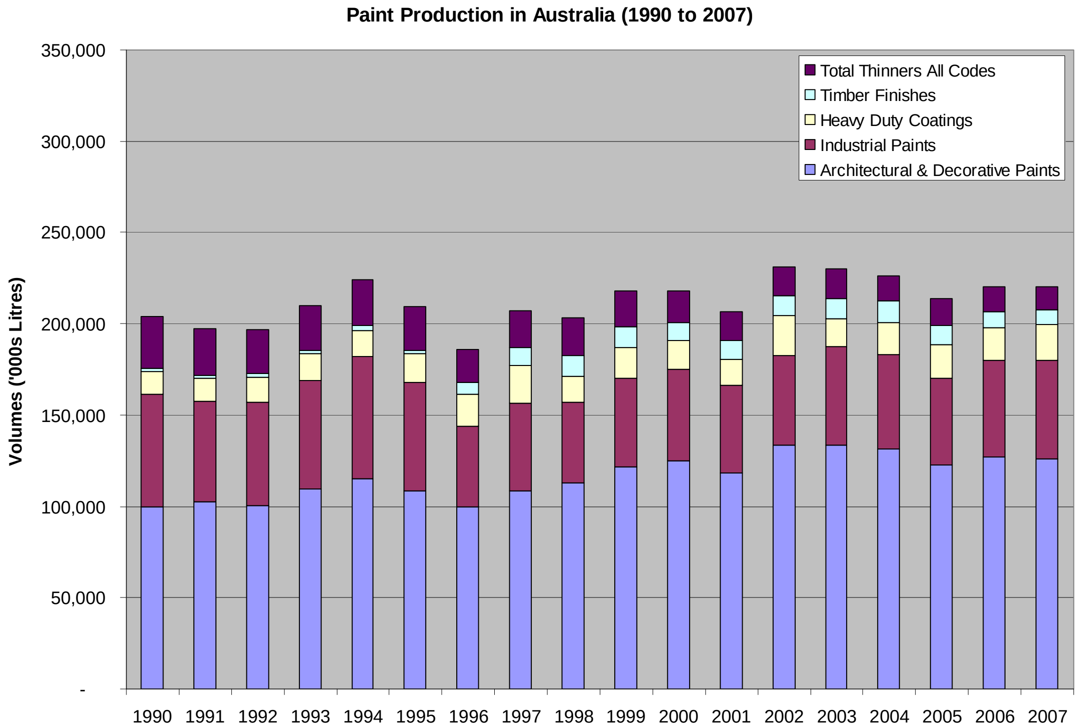


Figure 4: Range in total annual paint production in Australia between 1990 and 2007 (APMF, 2008)

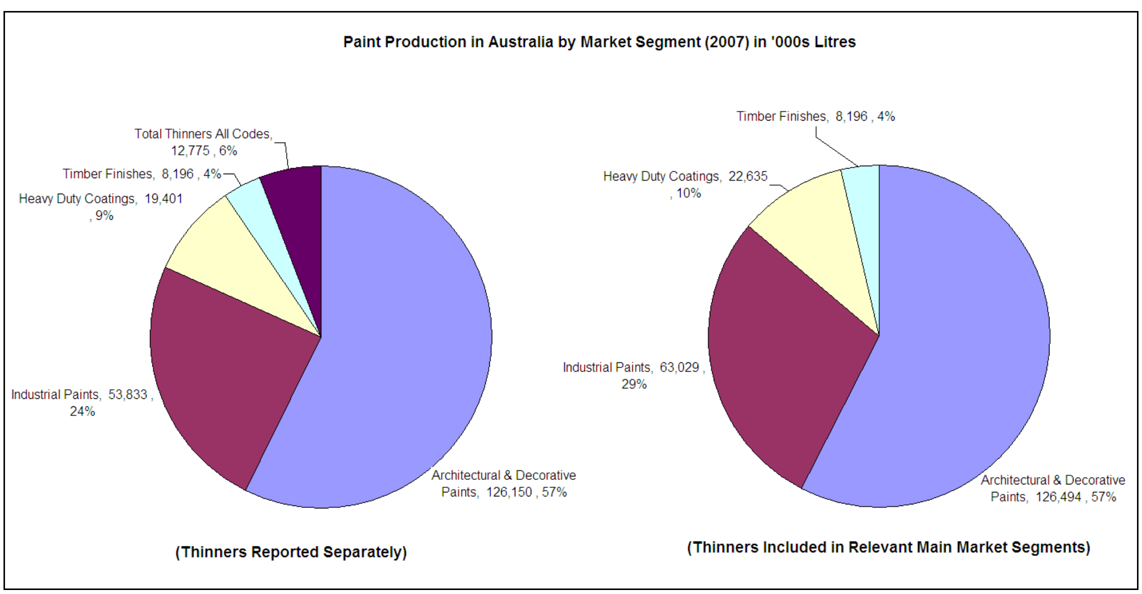


Figure 5: Paint production volumes in Australia (2007) given by market segment (APMF, 2008)

Thinners are reported separately in the inter-annual figures, but are generally associated with a particular sector. In 2007, for example, thinners were allocated in the following proportions to the architectural and decorative (2.7%), industrial (72%) and heavy duty coatings (25.3%) segments. Apportionment of 2007 production figures by market segment, including and excluding thinners, is illustrated in **Figure 5**. Including thinners, Architectural & Decorative accounts for 57%, Industrial for 29%, Heavy Duty Coatings for 10% and Timber Finishes for 6% of total 2007 production volumes.

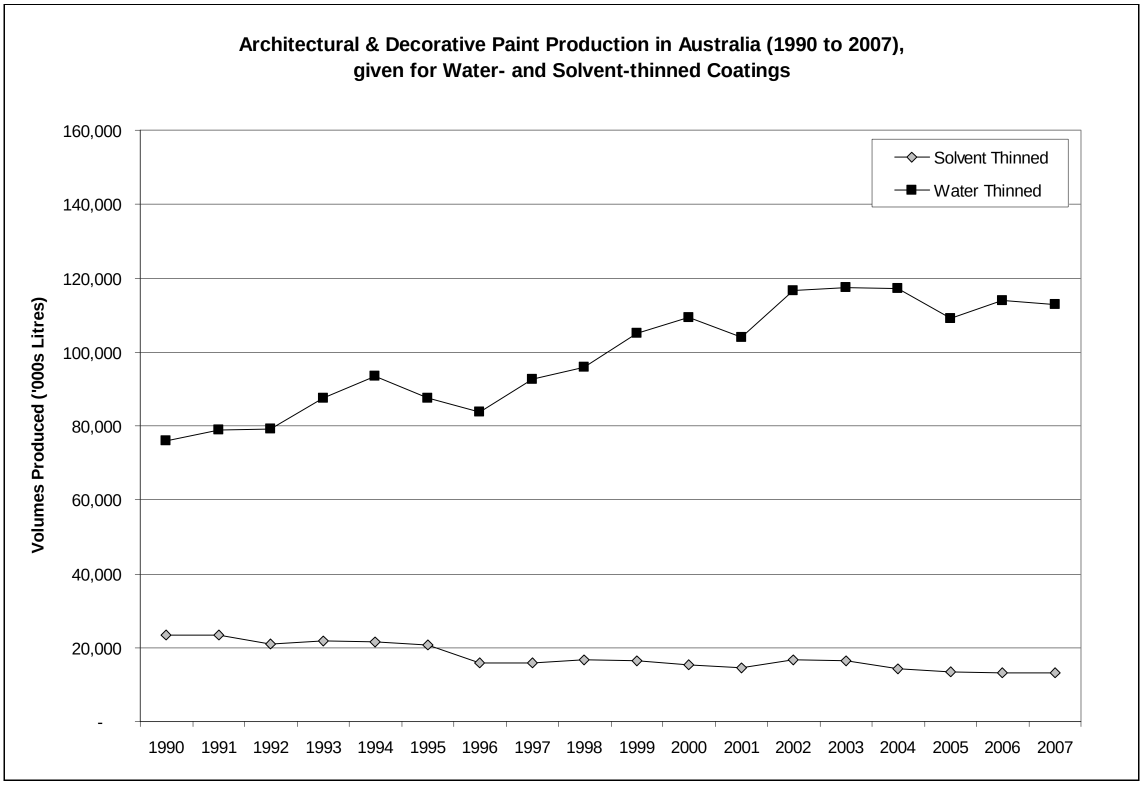


Figure 6: Trends in water-thinned and solvent-thinned Architectural & Decorative paint production (1990 to 2007) (APMF, 2008)

Architectural & Decorative paints are applied on site to new and existing residential, commercial and industrial buildings. Industrial paints include coatings which are factory-applied to manufactured goods as part of the production process, and include Original Equipment Manufacture (OEM) coatings.

Products with the Architectural & Decorative segment can be categorised into two main groups: water-based and solvent-based. Due to the lower costs involved in producing water-based paints and growing environmental concerns associated with solvent-based paints, there has been a consistent and growing trend over the past two decades towards the production of water-based paints (**Figure 6**). Consumers also pay a relatively significant premium for solvent-based paints over the water-based substitutes, thus adding to the trend away from their usage (IBISWORLD, 2008).

Over the 1990 to 2007 period, the production of water-based paints has increased from 76% of total Architectural & Decorative paints produced in 1990 to 90% in 2007. This is significantly higher than the proportion of water-based Architectural & Decorative paints produced in 1974 which is given as having been 60% (APMF, 2008).

3.1.2 Paint Exports and Imports

During the October 2006 to September 2007 period paint exports and imports were recorded as follows (Australian Bureau of Statistics, 2008):

- 13,435 kilolitres exported (comprising 31.4% water-borne)
- 18,368 kilolitres imported (33.7% water-borne)

Based on the statistics it is evident that only about 6% of locally produced paints are exported, with paint imports comprise approximately 8% of the total local market. This is largely due to the nature of the product. Paint tends to be a high volume, low value item which requires special packaging and transportation procedures, and therefore does not lend itself readily to international trade.

The local industry has to date been sheltered to some extent from import competition in major market segments due to the high ratio of freight costs to product values and the need to manufacture to suit Australian conditions (IBISWorld, 2008).

In the industrial segment, the technical performance of products is often the main competitive differentiator, allowing industry players to build niche businesses which command higher margins and therefore make product imports more viable. The need to use coating products which meet international specifications may also drive the importation of products within certain industrial sectors (e.g. marine, aviation).

Both imports and exports are dominated by solvent-borne paints. Paint imports by country are illustrated in **Figure 7** for water-based and solvent-based paints. The USA, Germany, Italy, Malaysia, Singapore, New Zealand and Japan together account for over 80% of the water-based paint imports. The USA, New Zealand, Sweden, Germany, Thailand, Singapore, China, Italy and the Netherlands represent the most significant countries in terms of solvent-borne paint imports. Singapore frequently acts as a base for paint products being exported by various Asian countries. The importance of Japan as a source of water-based paints is expected to increase from 2008 onwards due to Bunnings decision to market Nippon paints.

Paint exports by country are illustrated in **Figure 8** for water-based and solvent-based paints. The most prevalent destinations for Australian produced water-based paints are New Zealand (20%) and China (17%). It is notable that 57% of all Australian produced solvent-based paints are exported to New Zealand, with 11% to China. Other markets for export include other Asian countries, the USA, Indonesia and Malaysia being smaller markets.

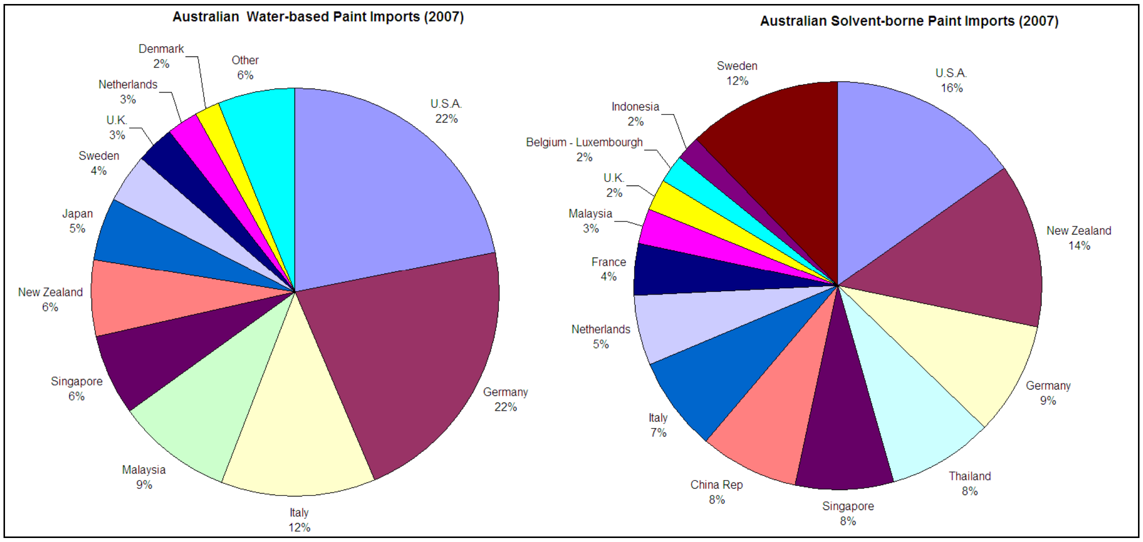


Figure 7: Australian paint imports by country for 2007 (ABS, 2008)

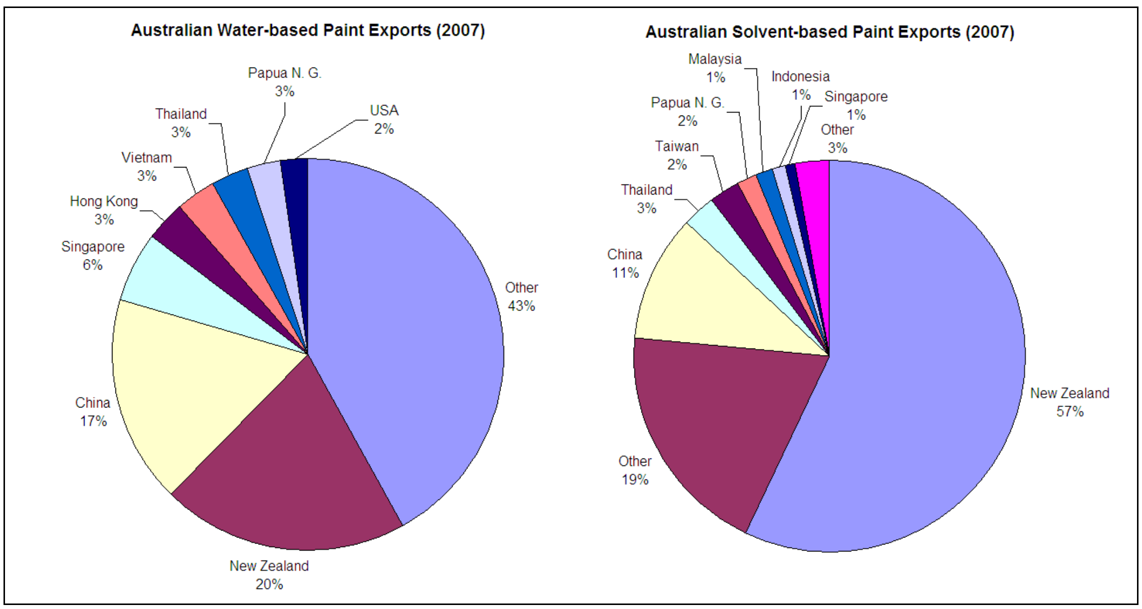


Figure 8: Australian paint imports by country for 2007 (ABS, 2008)

Although a distinction is made between water-borne and solvent-borne paints, export and import data are not available by product type.

An attempt was made to collect export and import data during Survey 1. Due to this data only having been supplied by certain paint manufacturers, the data set was incomplete with data only having been collected for approximately 34% of exports and less than 10% of imports. Based on the data received it was however evident that significant quantities of

Automotive (OEM and Car Refinish) paints and Heavy Duty Coatings are both imported and exported.

Automotive OEM paints were given as having been imported from the USA, and exported to China, Taiwan and Southeast Asian countries. Automotive Car Refinishing products were given as having been imported from the USA, Belgium and the Netherlands, and exported to the USA, New Zealand, Fiji and PNG.

Heavy Duty Coatings (including protective coatings and marine) were given as having been imported from the USA, Singapore, Belgium, the Netherlands and the UK, with exports to New Zealand and PNG.

Architectural & Decorative coatings imports were also notable, with China given as the primary destination by companies having completed the survey. Due to data not having been available from paint retailers not involved in manufacturing, statistics of Architectural & Decorative imports could not be obtained.

3.1.3 Paint Sales

Architectural & Decorative Paint sales statistics are collected by Informark, with Industrial Paint sales data published by the APMF. A synopsis of the sales volumes for 2007 is given in **Table 7**.

Table 7: Paint Sales data for 2007

Market Segment	Volumes (kilolitres)	Source
Architectural & Decorative Paints(a)	141,432	Informark (2007) Sales Data for Architectural & Decorative
Industrial Paints(b)	50,214	ICC (2007) Industry Sales Data
Heavy Duty Coatings(c)	16,452	ICC (2007) Industry Sales Data
Timber Finishes (d)	10,357	ICC (2007) Industry Sales Data / Informark (2007) Sales Data for Architectural & Decorative Wood Care
Total Thinners	9,843	ICC (2007) Industry Sales Data
Total All Products	**228,298**	

(a) Excludes spray packs, of which 1,529,791 units were sold in 2007.

(b) Includes Automotive (18%), Can & Coil (48%), Flat Board (4%) and Other Industrial (29%).

(c) Includes Protective Coatings (60%), Marine (10%) and Road & Runway Marking (30%).

(d) Includes industrial wood care (4,065 kilolitres, 39%) and architectural and decorative wood care (6,292 kilolitres, 61%).

The Architectural & Decorative segment, including paints and wood care, accounts for 65% of the total sales. The decorative market comprises retail sales to household consumers

(DIY), and trade sales to tradesmen and master painters. Trade sales comprised over 60% of architectural and decorative paint sales and 12% of Architectural & Decorative wood care sales during 2007 (Informark, 2008). Trade sales are also reported to have increased at a faster rate than retail sales in recent times. Sales made to the overall architectural and decorative segment have also tended to gradually increase (IBISWORLD, 2008).

3.2 Industry Players

The aggregated industry concentration is considered to be high, with major players continuing to gain market share at the expense of smaller firms with weaker distribution links and lower cost competitiveness (IBISWORLD, 2008). Niche players have however noted to have maintained their share in specialised segments of the industry.

The Australian paint industry tends to be dominated by industry players who operate globally. These include foreign based companies such as Akzo Nobel (Netherlands), PPG Industries (US), BASF Coatings (Germany) and Valspar (US). Other major players in the industry which operate on an international scale include Australian based companies such as Orica and Wattyl, though in recent years both companies have sought to reduce their international operations (IBISWorld, 2008).

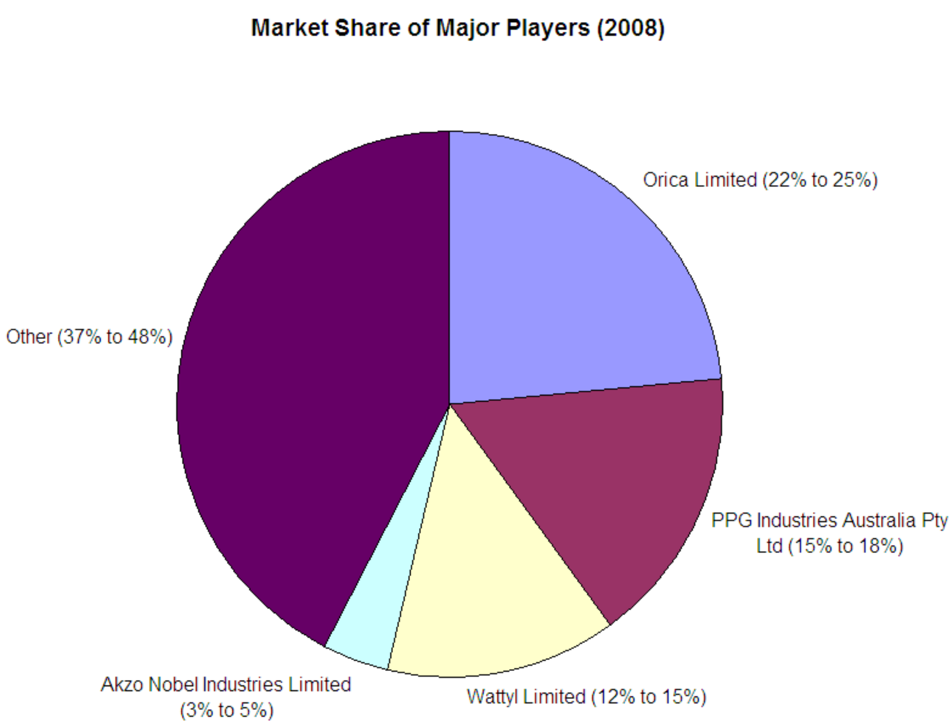


Figure 9: Market share of major players within the Australian paint industry (2008) (IBISWorld, 2008)

3.2.1 Orica Limited (22% to 25% market share)

Orica Consumer Products (OCP) is a manufacturer and marketer of branded consumer products used in home improvement, architectural maintenance and construction. Products include paints and stains, texture coatings, powder coatings, paint preparation products, car care and garden care products. The business operates in Australia, New Zealand, Papua New Guinea, Hong Kong, Singapore, Malaysia and China.

Orica Consumer Products' principal business units which operate within the surface coating sector include Decorative Coatings, Wood care, Powder Coatings and Orica Coatings.

Decorative Coatings is Australasia's largest manufacturer and supplier of surface coatings including the Dulux, British Paints, Acra Tex, Berger, and Walpamur brands. The Decorative product range includes protective coatings and solvent and water-based paints for both retail and trade markets (Orica, 2008).

OCP's Wood care business is Australia's largest manufacturer and supplier of timber finishes including stains, polyurethanes and oils for both consumer and professional users under the brand names of Cabot's, Feast Watson, Intergrain, Toby and Enviropro. Orica Coatings also markets a range of Wood care coatings to offshore markets to suit the needs of overseas customers (Orica, 2008).

Dulux Powder Coatings offers a range of powders that can be used over a multitude of surfaces, including aluminium, steel, zinc coated metals and, more recently, heat-sensitive substrates. The product range includes super-durable powders and paints such as Fluoroset, Duratec and Duralloy for architectural applications; Alphatec, Copol and Microtec for industrial application; and functional powders such as Armourspray VC, Zincshield, Durepoxy and Pyrotec. The new range of heat-sensitive powder coatings includes Trimatrx and Xienta (Orica, 2008).

Powder Coatings' architectural applications include coating of aluminium extrusion used to fabricate window frames and shower screens, and industrial coatings on steel chair frames, pallet racking, office furniture, light fittings, tools and pool fencing. Applications for Trimatrx and Xienta include office work stations, shop fittings and commercial interiors (Orica, 2008).

Orica Coatings supplies a range of Decorative, Texture, Wood care, Protective and Powder and Fluoropolymer Coatings to offshore markets including South East Asia and China (Orica, 2008).

OCP previously manufactured a range of technical coating products to service the automotive, coil, packaging, production coatings and automotive refinish markets. Its technical coatings business was however sold in 1998 as part of its strategy to focus on decorative paints, wood care products, textured and powder coatings. Given that the automotive paints industry was becoming a global, high-technology business contributed to OCP's decision to sell to PPG Industries, a leading global automotive paint company (IBISWorld, 2008).

Currently approximately 75% of OCP's revenue by end market derives from maintenance and home improvement, 20% from building and construction and 5% from industrial

(Houlihan, 2008). It is reported to hold around 47% of the decorative paint market and to be the number one seller in the industry.

Orica's manufacturing facilities within Australia are located in Dandenong, VIC (paints & stains), Clayton, VIC (powder coatings), Beverley, SA (texture coatings), Rocklea, QLD (paints & stains) (Orica, 2008).

Orica owns trade centres and depots for the distribution of its trade paints, and has strong links with major retail chains such as Bunnings, K Mart and Big W and independent paint specialist stores (IBISWorld, 2008).

3.2.2 PPG Industrial Australia Pty Ltd (15% to 18% market share)

PPG Industries Australia (PPG) is a subsidiary of the US company PPG Industries, the second largest global coatings company operating 125 manufacturing facilities in 25 countries. PPG entered the Australian Market in 1998 with the acquisition of the technical coatings business of Orica.

Further acquisitions by PPG included Protec Pty Ltd in 2006 and Barloworld Coatings Australia in 2007. Barloworld Australia's brand names included Taubmans, Bristol and White Knight, with Barloworld the third largest player within the decorative paint segment and Taubmans and Bristol thought to have a market share of 22% of the Australian decorative paint market.

PPG is currently involved in the manufacture, import and sale of coatings and resins, chemicals and glass. It operates from three plants (Clayton, VIC; Adelaide, SA; Villawood, NSW). PPG's surface coating related business units include:

- Aerospace – Sealants, coatings, serving original equipment manufacturers and maintenance providers for the commercial, military, regional jet and general aviation industries.
- Architectural Coatings – Brands include Pittsburgh Paints, Olympic, Porter, Monarch and Lucite. This unit produced paints, stains and speciality coatings for commercial, maintenance and residential markets.
- Automotive Coatings – Global supplier of automotive coatings and services to auto and light truck manufacturers. Products include electrocoats, primer surfacers, base coats, clear coats, pre-treatment chemicals, adhesives and sealants.
- Automotive Refinish – Products and markets a full limit of Car Refinish products for automotive repair and refurbishing, light industrial coatings and speciality coatings for signs.
- Industrial Coatings – Wide range of value-added coatings for appliances, agricultural and construction equipment, consumer products, electronics, heavy-duty trucks, automotive parts and accessories, residential and commercial construction, wood flooring, kitchen cabinets and other finished products.
- Packaging Coatings - Global supplier of coatings for metal and plastic containers for the beverage, food, general line and speciality packaging industries.

- Protective and Marine Coatings – Leading global supplier of corrosion-resistant, appearance-enhancing coatings for the marine, infrastructure, chemical processing, oil and gas and power industries.

3.2.3 Wattyl Limited (12% to 15% market share)

The Wattyl Group is a paint and surface coatings business with manufacturing, sales and distribution operations in Australia and New Zealand. Wattyl produces a wide range of paints, lacquers, varnishes and special purpose and protective coatings.

Within Australia, Wattyl operates four business segments, viz. Wattyl Retail, Wattyl Trade, Solver and industrial. The group operates three manufacturing facilities located in New South Wales (Blacktown), Victoria (Footscray) and South Australia (Kilburn).

Wattyl brands in Australia include: Solagard (exterior), Estapol (timber), Killrust (metal finishes), i.d. (interior), Pascol (interior and exterior), Solver (exterior and interior), Taubmans (New Zealand), and Granosite (texture). During 2008, Wattyl launched a new range of Wattyl Industrial Protective and Marine Coatings to strengthen its position in the industrial sector (Wattyl, 2008).

Wattyl holds between 12% and 15% of total market share for the industry as a whole. It is thought to manufacture approximately 40 million litres of paint per annum, with its architectural and decorative product range accounting for about 80% of its Australian revenues (IBISWorld, 2008).

Wattyl's retail paints have been sold in major hardware stores such as Bunnings, Mitre 10, John Danks, Paint Place, Paint Spot, Paint Right and Big W. The decision by Bunnings to introduce imported paint, impacted on various local paint manufacturers including Wattyl with certain products having been withdrawn by the retailer.

Trade paints are sold via company owned trade paint stores as well as via independent trade paint centres. Wattyl recently established Granosite 'Hub' stores in each State to create a stronger presence in the growing texture market and added various additional new stores to the Solver distribution network (Wattyl, 2008).

Wattyl produces a range of low VOC paints which meet APAS specifications. Recent product developments include EcoTint, a low odour and low VOC tinter and Wattyl Aqua Trim, a low odour acrylic enamel for interior use which received accreditation by Good Environmental Choice of Australia for its low impact on the environment (Wattyl, 2008).

3.2.4 Akzo Nobel Industries Limited (5% market share)

Operating from 80 countries with its headquarters in the Netherlands, Akzo Nobel NV is a technology based group involved in the manufacture of coatings (64% of 2007 revenues) and chemicals (36%). During 2007, its Decorative Paints operations accounted for 36% of revenues, its Protective Coatings operations for a further 32%, and its Speciality Chemicals operations for the remainder. In early 2008, it expanded its global coatings operations with the purchase of the UK coatings and chemical manufacturer Imperial Chemical Industries (ICI) (IBISWorld, 2008).

Akzo Nobel's Coatings division encompasses a wide range including decorative paints, powder and speciality coatings, car refinishes, marine, protective and aerospace coatings and coatings related products such as wood and building adhesives for professional painters, industrial applications and the DIY sector. Key product areas globally include decorative paints (36% of 2007 sales), industrial (31%), car refinishes (14%) and marine and protective coatings (19%) (IBISWorld, 2008). Key brands include Sikkens, International, Crown and Interpon.

Akzo Nobel currently mainly operates in the industrial and automotive refinishing paints segments in Australia. It produced industrial and marine paint through factories in Brisbane (5 million litres per year) and Perth (1 million litres per year). According to IBISWorld (2008) it claims to be the leading coatings player in the car repair, commercial vehicles and automotive plastic coatings segments. Akzo Nobel formed a joint venture with BASF Coatings for automotive OEM coatings in Australia called BASF Akzo Nobel Automotive OEM Coatings Pty Ltd but sold its 50% interest in 2005.

3.2.5 Other Industry Players

Orica (Dulux), Wattyl and PPG together account for over 90% of the Architectural & Decorative coatings market. Other players in this industry include small, regional manufacturers such as Amazing Paints and Cameleon Paints and manufacturers who occupy niche markets segments with various specialist paints. Examples of the latter include: Haymes Paint which markets the official restoration paint of the National Trust of Australia, Vipon's Paints which uses lead free organic paint pigments, Parr Paints which produces paint and textile coatings, and Porter Paints which specialises in lime based products (IBISWorld, 2008; DECC, 2007).

Key players in the Industrial Coatings segment include Akzo Nobel, Orica, PPG and Wattyl, in addition to Mirotone and Valspar. Mirotone is one of the largest manufacturers in Australia of industrial surface coatings for wood and wood related substrates. A 100% Australian-owned company, Mirotone's sales divisions are industrial wood and speciality coatings, floor coatings and maintenance systems, and print and packaging coatings. Valspar (Australia) Corporation, is a subsidiary of the Valspar Corporation which operates 32 manufacturing plants in the USA, Canada, Mexico, France, Norway, the UK, Australia, China and Singapore.

Hempel Marine Paints, PPG, Wattyl and Akzo Nobel are all active in the Heavy Duty Coatings segment. Others include Jotun (Australia), Resene Paints and Corrosion Control Management (Australia). Hempel produce marine, yacht, protective, decorative and container coatings.

Players in the Automotive Coatings market include Akzo Nobel, BASF Coatings, PPG, DuPont and Concept Paints. BASF Coatings, the Coatings Division of the BASF Group, develops, produces and markets a range of automotive OEM coatings, automotive refinishes and industrial coatings as well as decorative paints. In Australia, under the name of BASF Coatings Australia Pty Ltd and operating out of Sydney, BASF has a significant market position in the automotive OEM and refinish coatings business. DuPont Coatings & Color Technologies Group's platform includes its core markets of automotive, collision repair, paper, industrial coatings, architectural coatings and plastics. The company offers liquid and powder coatings as well as specialty products.

3.2.6 Coatings Retailers and Users

Some of the major players and other smaller players have company owned stores, whilst others have distribution arrangements with trade dealerships with hardware and paint specialist resellers.

Retail outlets established by industry operators, catering for both trade and D.I.Y customers, include Dulux Trade Centres, Bristol Decorator Centres and Wattyl Trade depots.

Hardware superstore chains Bunnings and Mitre 10 are thought to account for over 50% of all retail architectural coatings sold within Australia (IBISWorld, 2008). Other retailers include John Danks, Paint Place, Paint Spot, Paint Right, Big W and K Mart.

Historically Bunnings and Mitre 10 have predominantly sold coating products from Australian industry operators. Mitre 10 continues to do so. Bunnings launched imported Nippon Paints[(3)] in 2008. This development is anticipated to increase the involvement of paint manufacturers in downstream retail activities, specifically within the Architectural & Decorative paint segment.

A synopsis of the main users and sales and distribution mechanisms for coatings is given in Table 5**.**

3 Nippon Paint is Japan's oldest paint company is also its largest. It produces coatings for the automotive and marine markets as well as other industrial products, in addition to making paints for residential and commercial buildings and for the do-it-yourself market. Nippon Paint's manufacturing operations are located principally in Asia, but the company also has facilities in North America and Europe.

Table 8: Users, Sales and Distribution of Coating Product Segments

Product Group	Users	Sales and Distribution
Architectural & Decorative	Public Trade Painters Government	Ex-factor retailers Retailers Tender
General Industrial	Manufacturing: Agricultural Implements Appliances (White Goods)	Direct sale to end user
Heavy Duty Coatings	Aluminium Extrusion Industry Mining Ship building Bridges Oil rigs Pipelines Government	Direct sale to end user or by tender procedures
Automotive OEM and Automotive Refinish	New car production Refinishing / smash repair shops	Direct sale to manufacturers Direct sale to end users
Coil Coats	Producers of sheet metals, e.g. aluminium industry	Direct sale to end users
Can Coatings	Can coats for food and beverages Soft tube coatings	Direct sale to end users

Source: APMF.

3.3 Technological Developments

Paint production is undertaken as a batch process, with a wide range of raw materials being blended. Raw materials include organic and inorganic pigments, resins (also known as binders or polymers), solvents and additives.

Manufacture of pigmented paints requires the dispersion of pigments into part of the binder and solvent components, using high-speed dispersers or other grinding mill devices such as sandmills, beadmills and ballmills.

Historically technology used in the paint industry tended to be imported from abroad. Technology had however become increasingly modified to meet local performance requirements. Such locally technologies are being exported to Asia-Pacific countries.

Changes in technology has progressed slowly in the paint industry, with the most significant technology shift in the past 30 years being the decline of solvent-based paint production in favour of water-based paints due to growth in environmental concerns over solvent emissions (IBISWorld, 2008).

Technologies currently in use include (APMF, undated):

- improved low solids (<70%), solvent-based systems
- high solids (>70%), solvent-based systems
- water-borne coatings
- reactive (two-part catalysed) systems
- powder coatings, and
- radiation cured systems (ultra-violet and electronic beam).

The shift away from solvent-based paints has been accelerated by developments in radiation curing systems, powder coatings and high solids. These systems are growing at rates of 5% to 8% per annum (APMF, undated; IBISWorld, 2008).

A further technological development involves the use of nanotechnology to develop photocatalytic and self cleaning paints. It is anticipated that the application of this technology would be accelerated by stringent VOC regulations (IBISWorld, 2008).

Several of the international players started the process of reducing VOCs in their products several years ago to meet regulations in the US and/or Europe. This has included the investment in new research and development, the development of new technologies and reformulation of certain products, making available water-borne and high-solids products, and the updating of technical data sheets.

Certain Australian-owned manufacturers have also invested in managing the VOC content of their products. Wattyl produces a range of low VOC paints which meet APAS specifications. Mirotone, active in the wood coatings sector, has adopted an approach of increasing application solids where possible and reducing the photochemical ozone creation potential or reactivity (MIR value) of its solvent blends. It has achieved large reductions in MIR values by reducing its usage of aromatic hydrocarbons (Dennis, 2008).

3.4 Health and Environmental Drivers for Market Change

The following health and environmental factors are driving market change within the Australian coatings sector:

- Indoor air quality guidelines are becoming more stringent (e.g. Australian Building Codes Board), and risks of indoor air quality regulated litigation threats are increasing.
- Green Building Council of Australia's Green Star rating system for buildings with emphasis on the use of low VOC coatings.
- International trend towards the setting of ambient air quality standards for a wider range of pollutants, including individual VOCs (toluene, xylene, etc.).

- Increasing pressure to reduce precursors of ground-level ozone, and contributors to global climate challenges.
- Increasing consumer demands for more environmentally safe coatings and increased availability of information to consumers through mechanisms such as the Australian Environmental Labelling Association. This includes the Good Environmental Choice Label's Architectural and Protective Coatings Standard which specifies VOC levels of given products.
- International trends in terms of tightening of regulatory requirements aimed at moving paint manufacturers towards low or zero-VOC paints. Notable in this regard are the US (especially California), the EU, and more recently Canada.
- Recent acceleration of innovation with regard to low and zero-VOC paints as a result of such international and local trends.

3.4.1 APAS-related VOC Requirements

Solvent-based coatings used in Australia typically contain between 30% and 70% VOCs by weight and water-based coatings contain about 6%. Australian coatings manufacturers have been voluntarily reducing VOC levels over the past 15 to 20 years. This voluntary reduction is currently included into the Australian Paint Approvals Scheme (APAS), a government based, voluntary performance specification scheme.

The APAS D181 approvals agreement specifies both an average and maximum VOC level for a number of products. This enables a company to produce a coating with a higher than average VOC levels, such as may be required by the DIY market, together with a lower than average trade product – provided that the average VOC level of the product line does not exceed that set out in APAS D181. Further information on APAS limits is provided in **Section 6**.

Paint manufacturing companies wishing to be included as government contract paint suppliers are required in a number of States to be accredited under the APAS scheme. In NSW, for example, only APAS accredited paints are used to paint schools. For this reason, the bulk of general architectural paints are accredited with APAS. Manufacturers have however less incentive to achieve APAS accreditation for speciality paints, since they are use in the private sector and are rarely used by government (DECC, 2007).

Despite certain VOC emission reductions having been achieved through voluntary measures, the current level of compliance with the APAS limits and sufficiency of voluntary limits in successfully managing current and future total VOC emissions are uncertain.

3.4.2 Voluntary Eco-Labelling

The "Environment Choice Australia" is a voluntary labelling standard that aims to identify environmental quality, regulatory and social performance criteria that products sold on the Australian market must meet to be considered as "best environment practice". The environmental criteria given for surface coating includes VOC content, titanium dioxide content, use of glycol ethers, heavy metals, carcinogenic and ozone-depleting substances and packaging. VOC levels identified by Environment Choice Australia as environmental best practice are provided in **Section 6**.

3.5 Market Share and Uptake of Ultra Low VOC Paints

Ultra low VOC paints comprise less than 10 g/l organic solvents. Poor uptake of such paints by Australian consumers and painters is in part due to a history of poor performance (since rectified by improved formulating practices) and partly due to lack of awareness by consumers of the health and environmental effects of the VOCs in paints (DECC, 2007).

Market research on 402 Sydney residents concluded that “there is no knowledge amongst paint consumers of the potentially harmful effects of normal paint products either to their health or to the environment”. It was also noted that consumers, painters and retailers believed water based paints to be ‘safe’.

The major paint companies, Orica, Wattyl and PPG all produce premium no-VOC or low-VOC decorative paints. The low and zero VOC paint products which are commercially available are generally not well known and are not widely used. Ultra low VOC paints are rarely used by governments and have limited uptake in the domestic market.

Interest in producing low VOC paints peaked in the lead up to the Sydney Olympics in 2000, at which time emphasis was placed on ground breaking environmental standards for construction. At that time Orica’s Dulux (now Berger) released Breathe Easy interior paint and Wattyl produced Clean Air 3.

Retailers reported in 2006 that ultra low VOC paints collectively formed 10% to 15% of the market. Since that time new low VOC products have been brought on to the market, e.g. under the Dulux brand (DECC, 2007).

Historically, issues related to poor performances of ultra low VOC paints have included poor application properties, slow drying rates, poor colour availability and short shelf stability (DECC, 2007). Various engineering solutions have however been developed to address these negative performance properties, including the reformulation of products and introduction of new types of raw materials. Also it is suspected that there may be a trade-off between the durability or washability of low VOC paints and their environmental benefits, the extent of this is still being determined.

Regardless of developments, perceptions of the poor performance of low VOC paints persist among shop assistants and professional painters impacting their current popularity. Research undertaken by Taverner found that advise of salespersons at the point of sale is a major driver of domestic choice of paints (DECC, 2007).

The price of ultra low VOC paints remains high due to their low production volumes. The price is however likely to be reduced as market volume increases.

3.6 Summary of Market Trends

A summary of key market trends within the surface coating industry are as follows:

- Presence of clearly defined product markets.
- Continued increase in the importance of water-based paints and corresponding decline in solvent based paints in the Architectural & Decorative paint market.
- Relatively slow rate of technological change.
- Slower growth in industry gross product relative to the general economy, evidence of a mature market.
- Rationalisation of manufacturing factories, products and brands and a growth in globalisation, partly due to the increasing degree of internationalisation among customers, particularly industrial and automotive players.
- Increasing involvement in downstream retail activities by manufacturers involved in the Architectural & Decorative paint segment.
- Move towards producing 'environmentally friendly' paints and coating products in line with more stringent environmental requirements.

Mergers and acquisitions have been a prominent feature of the coatings industry. This is given as being due to industry players trying to increase their economies of scale, market share and profitability.

Internationally there has been an increasing trend towards industry concentration. This trend is reflected in Australia, where a growing number of international players have entered the market, usually by acquisition. Currently four companies (Orica, Wattyl, PPG and Akzo Nobel) account for 50% to 60% of the market. Recent news indicates a continuation of this trend with the Sydney Morning Herald Business Day (21 October 2008) indicating that the Wattyl Group was contemplating a merger with one of its big rivals.

4 Coating Product Categorisation and Description

The outcomes of the study were listed as follows at the outset of the project:

- Identify, categorise and describe (according to end-use functionality and broad technical specification and technical requirements) all imported and locally manufactured coating products that are sold in Australia.
- For the groups of coating products listed above, to the extent possible, determine the:
  - range of coating products within different product categories, and describe them
  - volume of individual coating products and product categories sold
  - the proportion of locally manufactured and imported products in the marketplace by volume
  - proportion of products in each product category that are water-based and solvent-based
- Provide contextual and technical information about each product category.

Limitations on the achievement of these study objectives due to data accessibility constraints and the implications of existing product classification systems were addressed in the Interim Report (Environ, September 2008) and are summarised in **Section 1.3**.

4.1 Product Categorisation by Market Segment

The main factors affecting the coating product categorisation process included:

- Product classification systems which are already in use locally to inventory, report and compare data across the surface coating sector.
- These include: Informark Pty Ltd Sales Categories given for Architectural & Decorative Paints, Enamels and Wood care; Inter Company Comparison (ICC) Centre Quarterly Industrial Sales Statistic Survey categories; and ICC categories for the collection of Production Data for the Architectural and Decorative, Automotive, Other Industrial, Heavy Duty Coatings and Timber Finishes segments.
- Internal product categorisation of the major industry players. The availability of total VOC content and detailed solvent usage information was, for example, confined to predefined product types in many cases.
- Emphasis on product categories developed for sales rather than production due to the need to address end-use functionality.
- Product classification systems used locally and internationally for the specification of VOC limits.

  Significant differences in the market segment coverage and level of detail was noted across the various local and international product classification systems. Whereas the EU and APAS product categories are more general, detailed classification systems are specified by the US-EPA, CARB, Canadian EPA and Hong Kong EPD as indicated by the numbers of categories for which provision are made.

Following consideration of the above factors, and consultation with industry representatives, it became apparent that product categorisation for data collation purposes would need to be based on existing product classifications used for inventory and reporting of sales data.

The product categorisation system selected comprises three levels of classification:

1 – Market Segments

2 – Product Categories

3 – Product Types

The Market Segment and Product Categories defined for consideration in the study are outline in **Table 9**.

Table 9: Market segments and product categories selected

Market Segment	Product Category
Architectural & Decorative	Architectural & Decorative Paints & Enamels
	Architectural & Decorative Wood care
	Architectural & Decorative Thinners
Industrial	Road & Runway Marking
	Can & Coil
	Flat Board
	Powder Coatings
	Other Industrial
	Industrial Wood care
	Industrial Thinners
Automotive	Automotive OEM (including thinners)
	Automotive Refinishing (including thinners)
Heavy Duty	Marine
	Yacht & Leisure Craft
	Protective Coatings
	Others (thinners)

Architectural & Decorative wood care and industrial wood care are typically grouped together under the class ‘timber finishes’, particularly when describing coating production. While noting similarities in the nature of many of the products used, it is useful to place them into separate market segments in terms of sales and usage.

In the production data collected by the ICC, road & runway marking coatings is placed within the ‘heavy duty’ segment. In practice, and in terms of usage and comparison with VOC limits, it is more applicable that such coatings be placed within the Industrial segment.

The terms Heavy Duty and Protective Coatings are often used interchangeably. For the purpose of the current study, ‘Heavy Duty’ is used to describe the entire segment, with heavy duty coatings not used for ships and boats referred to as ‘protective coatings’.

Following the collection of information across all market segments and product categories during the Phase 1 Survey, it was decided to limit the collection of detailed data to a sub-set of the defined categories. Product categories excluded from the definition of product types and the collation of detailed data, on the basis of their being used in either controlled or potentially controllable environments (based on local and international regulatory practices), were as follows:

Market Segment:	Product Categories:
Industrial	Can and coil
	Flat board
	Powder coatings (no VOCs)
Automotive	Automotive OEM

For ease of reference, the above product categories are subsequently referred to as 'source controllable coatings'.

Can & coil, flat board and automotive OEM coating products are used primarily in large industrial facilities where emissions either are, or could routinely be, regulated under license and VOC abatement measures required.

With regard to the marine and protective coatings market segment uncertainty exists regarding the potential for successfully placing VOC abatement requirements on end users (e.g. as is done in EU for marine). Marine coating applications in Australia are much smaller-scale and less centralized than abroad, with limits therefore on the potential for end use VOC control.

Protective coatings are applied in a range of environments, including on commercial buildings, construction sites (e.g. bridges & other infrastructure), building yards, specialist application project sites, steel maintenance & construction sites (etc.). These types of environments generally do not lend themselves to ready VOC abatement through the implementation of control technologies. It was however noted that commercial buildings are to some extent controlled due to the Green Building Council's VOC regulations.

4.1.1 Local Sales Volumes by Market Segment

A summary of the volume of surface coating products sold within Australia during 2007 is given in **Table 10** by market segment and product category. The source of the data provided is specified in the table. Reference was primarily made to the Informark (2007) Sales Data given for Architectural & Decorative including wood care, and to the ICC (2007) Industrial Sales Data (as documented in **Section 2.4.2**).

In the case of Automotive Coatings, the ICC Industrial Sales Dataset was incomplete, including primers, undercoats and finishing coats, but excluding other automotive coatings. Based on the automotive sales data collected during Survey 1 and the detailed APMF Production Data collated for Automotive Refinishing, an estimate was made of the likely additional volume of automotive coatings. This resulted in a further 1,029 kilolitres of coatings being added.

Although thinners are included in the automotive, industrial and heavy duty segments, thinners used within the decorative market was not accounted for. An estimate of thinner use within this market was made for inclusion (Ref Section **4.2.3**).

The addition of other automotive coatings and Architectural & Decorative thinners increased the total volume to 234,066 kilolitres (5,768 kilolitres higher than the 228,298 kilolitres documented in **Table 7** based on published data).

The total volumes of surface coatings sold in Australia during 2007, including and excluding 'source controllable coatings' are illustrated in **Figure 10** by market segment.

When 'source controllable coatings' are included, the proportion of volumes by market segment is as follows: Architectural & Decorative (64%), Industrial (23%), Automotive (7%) and Heavy Duty (6%).

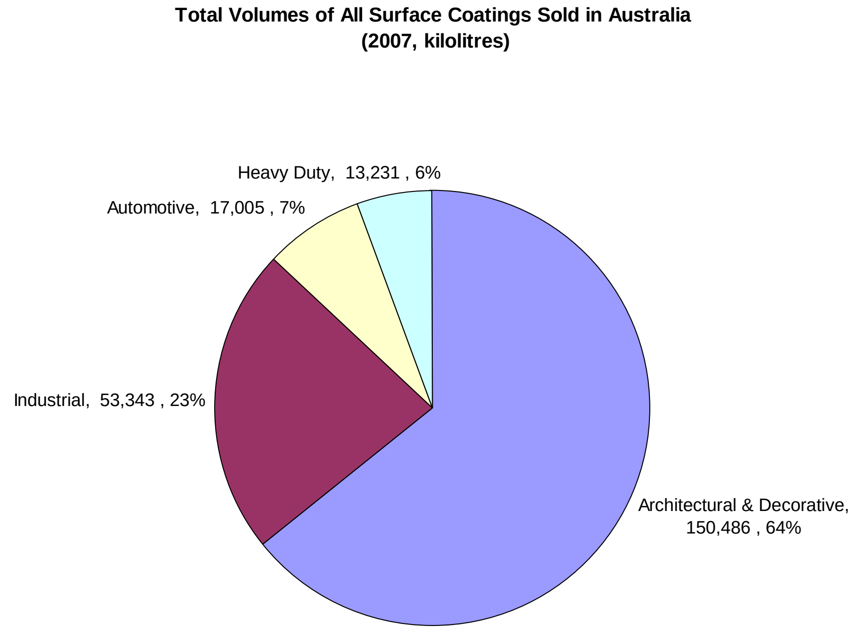
By excluding the 'source controllable coatings', i.e. Automotive OEM from Automotive, and Can & Coil, Flat Board and Powder Coatings from Industrial, the allocation of remaining volumes by market segment is as follows: Architectural & Decorative (75%), Industrial (13%), Automotive (5%) and Heavy Duty (7%).

Table 10: Volume of surface coating products sold within Australia during 2007 by Market Segment and Product Category(a)

Market Segment:	Volumes (kilolitres)	Product Category:	Volumes (kilolitres)	Basis
Architectural & Decorative	150,486	Architectural & Decorative Paints, Enamels & Clears (b)	141,495	Informark (2007) Sales Data for Architectural & Decorative
		Architectural & Decorative Wood care	6,292	Informark (2007) Sales Data for Architectural & Decorative Wood Care
		Architectural & Decorative Thinners	2,699	Estimated (Ref. **Section 4.2.3**)
Industrial	53,343	Road & Runway Marking	4,889	ICC (2007) Industry Sales Data
		Can & Coil	24,212	ICC (2007) Industry Sales Data
		Flat Board	2,241	ICC (2007) Industry Sales Data
		Other Industrial - Finishing Coats	6,021	ICC (2007) Industry Sales Data
		Other Industrial - Primers & Undercoats	9,874	ICC (2007) Industry Sales Data
		Industrial Wood care	4,065	ICC (2007) Industry Sales Data
		Industrial Thinners	2,041	ICC (2007) Industry Sales Data
Automotive	17,005	Automotive OEM	6,838	ICC (2007) Industry Sales Data & estimated automotive thinners based on ICC (2007) Production Data
		Automotive Refinishing	10,167	ICC (2007) Industry Sales Data, Survey 1 Data, Detailed APMF 2007 Production Data for Automotive Refinishing
Heavy Duty	13,231	Marine	1,012	ICC (2007) Industry Sales Data
		Yacht & Leisure Craft	653	ICC (2007) Industry Sales Data
		Protective Coatings	9,916	ICC (2007) Industry Sales Data
		PC Thinners	1,650	ICC (2007) Industry Sales Data
TOTAL	**234,066**			

(a) Volumes given by market segment in **Table 10** differ from those provided in **Table 7** due to: (i) the inclusion of data for other automotive coating products, (ii) the reclassification of certain of the product categories, and (iii) the inclusion of thinners where not previously included.

(b) Excludes spray packs, of which 1,529,791 units were sold in 2007.



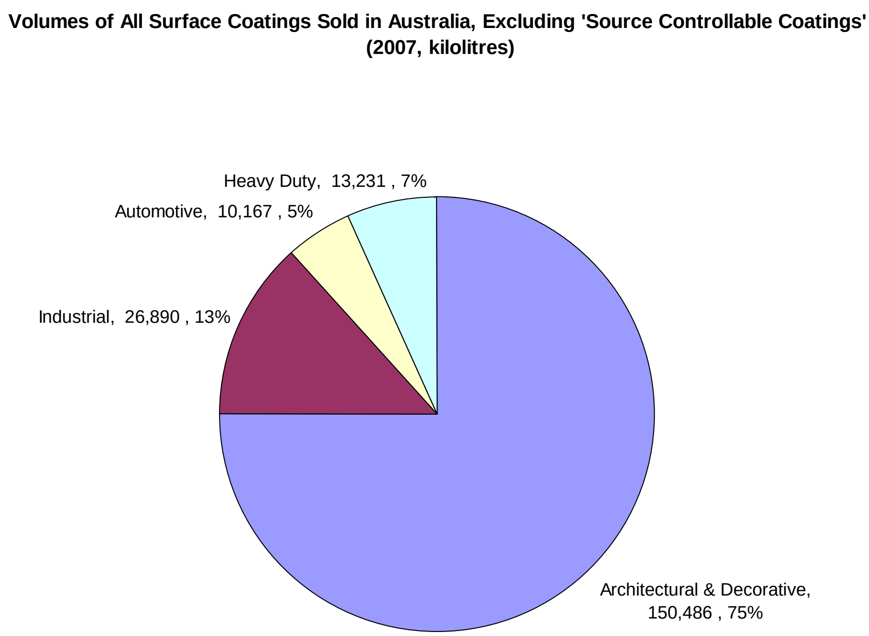


Figure 10: Volumes of all surface coatings sold in Australia during 2007, including and excluding 'source controllable coatings'

4.1.2 Low VOC and Solvent Borne Coatings by Market Segment

Solvent-borne coatings (SB) mean coatings the viscosity of which is adjusted by the use of organic solvent. Low VOC coatings include water-borne coatings (WB) which are coatings the viscosity of which is adjusted by the use of water.

Current Sales Statistics are incomplete in terms of distinguishing between water / low VOC and solvent borne coating sales. Neither the ICC Industrial Sales Data nor the Informark Architectural & Decorative Sales Data distinguish between water and solvent borne coating sales. It was therefore necessary to establish the ratio of low VOC/water-borne to solvent-borne coatings based on ICC Production Data and on the detailed data collected during Survey 1 and Survey 2. This ratio was established for all coating categories excluding 'source controllable coatings'.

In certain cases data was only collected from a sub-set of the industry, as described in **Section 2.5.1**. It is therefore necessary to provide an estimate of the representativeness of the data used to apportion coatings at water/solvent borne (**Table 11**). Detailed data were available for over 85% of the coatings (by volume) within each Product Category, with the exception of Industrial Wood Care.

Data for Industrial Wood Care were only available from manufacturers with a combined market share of about 60%. Given that these manufacturers tended to focus on solvent-borne technologies, the proportion of water-borne coatings within the Industrial Wood Care category (estimated at 2%) may be underestimated. It is however expected that the percentage of water-borne wood care coating within the Industrial segment will be significantly lower than that in the Architectural & Decorative segment (based on the comparison of volume weighted VOC contents calculated on Survey 1 data), i.e. likely to be <10%.

Table 11: Representivity of detailed coatings data set used, as a % of entire coatings category

Market Segment	Product Category	Representivity of Data (given as % of total sales volume accounted for)
Architectural & Decorative	Architectural & Decorative Paints & Enamels	>90%
	Architectural & Decorative Wood care	>90%
Industrial	Road & Runway Marking	~85%
	Other Industrial - Finishing Coats	>90%
	Other Industrial - Primers & Undercoats	>90%
	Industrial Wood care	~60%(a)
Automotive	Automotive Refinishing	>80%
Heavy Duty	Marine	>90%
	Yacht & Leisure Craft	>90%
	Protective Coatings	>90%
	PC Thinners	>90%

The percentage of low VOC / water-borne coatings sold within Australia within each of the main segments is as follows: Architectural & Decorative (89.7%), Industrial (45.8%), Automotive (7.9%) and Heavy Duty (0.7%). The percentage of low VOC / water-borne coatings sold within each of the Product Categories is illustrated in **Figure 11**. In the case of the heavy duty coating categories, products specified by some companies providing data were specified as being 'solvent free' or were assumed (based on the VOC content) to be a mixture of solvent-borne and solvent free coatings.

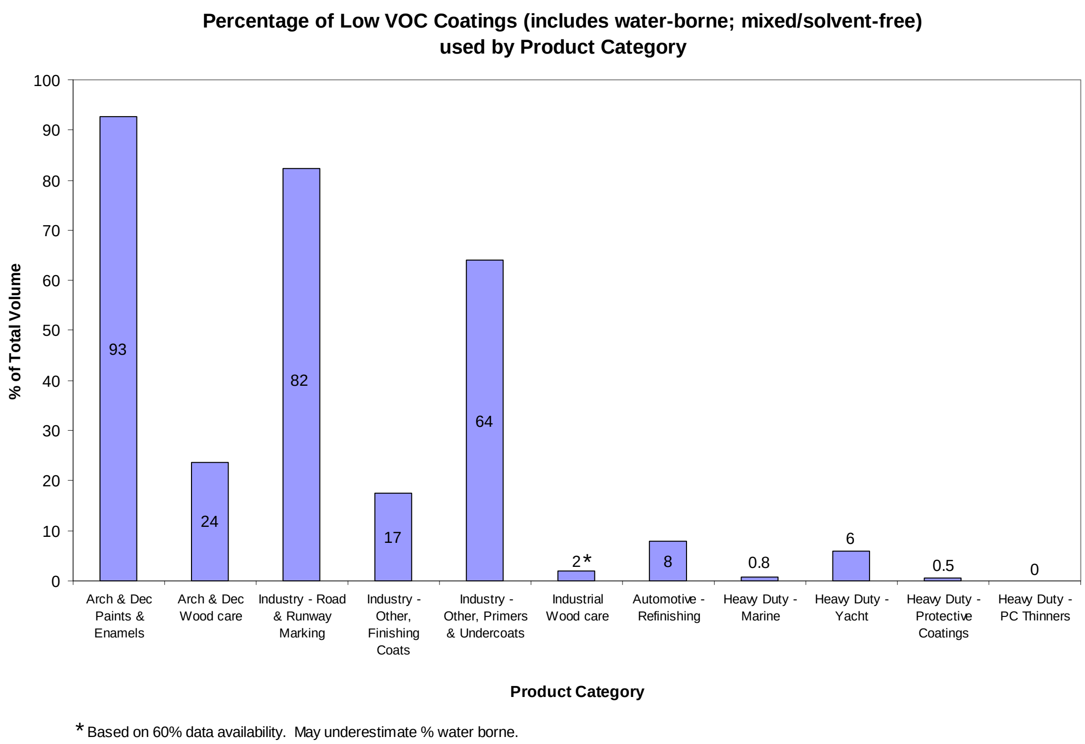


Figure 11: Proportion of low VOC (water-borne, mixed, solvent free) coatings sold within each Product Category (2007)

4.2 Architectural and Decorative Coatings

4.2.1 Definition of Decorative Paint

Reference may be made to the working definition for decorative paints derived during the European "Decopaint Study" (2000), given as follows:

> *"Decorative paints and varnishes are products that are applied to buildings, their trim and fittings, for decorative and protective purposes. They are applied in situ by professional or private users. While their main function is decorative in nature, they also have a protective role."*

The US-EPA (1998) defines architectural coating as “a coating recommended for field application to stationary structures and their appurtenances, to portable buildings, to pavement or to curbs”. The definition excludes “adhesives and coatings recommended by the manufacturer or importer solely for shop applications or solely for application to non-stationary structures, such as airplanes, ships, boats, and railcars”.

Based on such definitions and on common practice within the Australian market, the main characteristics of Architectural & Decorative coatings may be summarised as follows:

- Decorative in nature, with consumers of paints being mainly concerned with the aesthetic characteristics of the product, such as colour and gloss, rather than its protective properties.
- Application *in situ* to existing or new buildings, their trim and fittings including paving.
- Excludes coating products which are applied off site on factory production lines.
- Excludes coating products which are applied to non-stationary structure, e.g. airplanes, ships, boats and railcars.
- Exclusion of heavy duty coatings such as structural steel paints, since decoration is a very minor part of their function and they tend not to be applied by private users.
- Inclusion of some two-pack products that may be used by private consumers as well as professionals.

Architectural and decorative products used locally are mostly manufactured locally (unlike automotive refinishing for example), and tailored to suit local circumstances & environments. Requirements of such products are frequently different from abroad in terms of performance and application.

A distinction is made between two main Product Categories within the Architectural & Decorative Coatings Segment, namely: (i) Paints & Enamels, and (ii) Wood care.

The Architectural & Decorative Paint, Enamels & Clears category includes both solvent-borne and water-borne coatings, examples of which include:

Solvent-borne	*Such as:* * Primers & undercoats * Finishing coats, pigmented full gloss * Finishing coats, pigmented other than full gloss * Finishing coats, clears (include varnishes and clear plastic coatings such as floor treatment compounds and two-pack type coatings) *Exclude:* * Heavy duty coatings (include separately)
Water-borne	*Such as:* * Plastic latex primers & undercoats * Plastic latex flat finishing coats * Plastic latex finishing coats other than flat (satin, semi-gloss, gloss) * Water based other than plastic latex *Exclude:* * Heavy duty coatings (include separately)

Architectural & Decorative Wood Care is defined by the ICC as “all products sold for application to interior or exterior timber as a clear or a stain. It does not include primers and undercoats.”

4.2.2 Architectural & Decorative Product Types

The Product Types selected for the Architectural & Decorative Market Segment are listed and described in **Table 12**. These Product Types coincide with the types specified by Informark and for which data are routinely collated by the major industry players, with the exception that a distinction is made between solvent borne and water borne coatings.

Table 12: Description of Architectural & Decorative Product Types

Product Category	Product Type:	Base	Description:
Paints, Enamels & Clears	Paving Paint	S/W	Paint for concrete, brick, masonry and timber floors
	Roof Paint	S/W	Used on the exterior of buildings for finishing roofs, gutters and downpipes
	Metal finishes	S	Topcoats applied to metal surfaces
	Prepcoats	S/W	All interior and exterior primers, sealers and undercoats
	Door,Window,Trim	S/W	Topcoats - includes all water based gloss, solvent based gloss and solvent based semi gloss paints.
	Fence finishes	W	Topcoats applied to fences
	Specialty finishes	W	Primarily "Interior Textures" including all affects products such as 'suede', special finishes, craft, niche products etc. and all textured paint applied with a brush/roller.
	"Heavy end" texture coatings	W	Textured paint applied with a trowel.
	Ceiling Paint/Flat topcoats	W	All water based and solvent based flat paint
	Interior topcoats	W	Interior and interior/exterior topcoats - includes all water based semi gloss and water based low sheen paints.
	Exterior topcoats	W	Exterior water based gloss, semi gloss and low sheen paints.
Wood care	Decking paint	S/W	Coatings designed for application to wood which produce a transparent or semi-transparent film for decoration and protection of wood. Including opaque wood stains.
	Flooring	S/W	Typically clear water based (polyurethane) or solvent based timber flooring finish.
	Interior stains	S/W	Coating applied internally to wood, formulated so pigment penetrates the surface. Stain is predominantly pigment or dye and solvent with little binder, designed primarily to add colour without providing a surface coating. (Stains are shellacs or varnishes with colourants. The stain colours but does not obscure the grain of the surface.)
	Exterior stains	S/W	As above, but stain for external application to wood.
	Prepcoats	S/W	All primers, sealers and undercoats
	Interior clears	S/W	Coatings applied to wood internally or in protected environment which produce a transparent film for decoration and protection of wood.
	Exterior clears	S/W	As above, but for external use.

S – Solvent borne; W – Water borne

Volumes of each Product Type sold in Australia in 2007 are given in **Table 13** and illustrated in **Figure 12** and **Figure 13** for Paints, Enamels & Clears and for Wood Care respectively.

The architectural and decorative segment comprises retail sales to household consumers (D.I.Y.), and trade sales to trades people and master painters. Thought to be the larger of the two, trade sales have also increased at a faster rate than retail sales in recent times (IBISWorld, 2008). The proportion of trade sales is given in **Table 13**, based on the Informark Sales Data for 2007. It is estimated that about 60% of decorative coating sales comprise trade sales, with texture coatings, ceiling paint and prepcoat sales in particular being dominated by trade purchases.

Table 13: Architectural & Decorative Product Type Volumes and % Water-borne (2007)

Market Segment	Product Category	Product Type	Volume (kilolitres)	% Trade	% Water Borne
Architectural & Decorative	Paints, Enamels & Clears	Paving Paint	1,680	24	47
		Roof Paint	299	48	76
		Metal finishes	1,585	21	-
		Prepcoats	14,838	62	82
		Door,Window,Trim	6,933	49	24
		Fence finishes	1,026	1	100
		Specialty finishes	2,293	17	100
		"Heavy end" texture coatings	31,031	98	100
		Ceiling Paint/Flat topcoats	17,444	67	100
		Interior topcoats	41,284	52	100
		Exterior topcoats	23,084	53	100
		SUB-TOTAL	**141,495**	**63**	**93**
	Wood care	Decking Paint	3,106	10	10
		Flooring	699	14	14
		Interior stains	433	9	17
		Exterior stains	534	11	50
		Prepcoats	415	10	80
		Interior clears	835	24	22
		Exterior clears	270	21	90
		SUB-TOTAL	**6,292**	**13**	**24**
Architectural & Decorative TOTAL			**147,788**	**61**	**90**

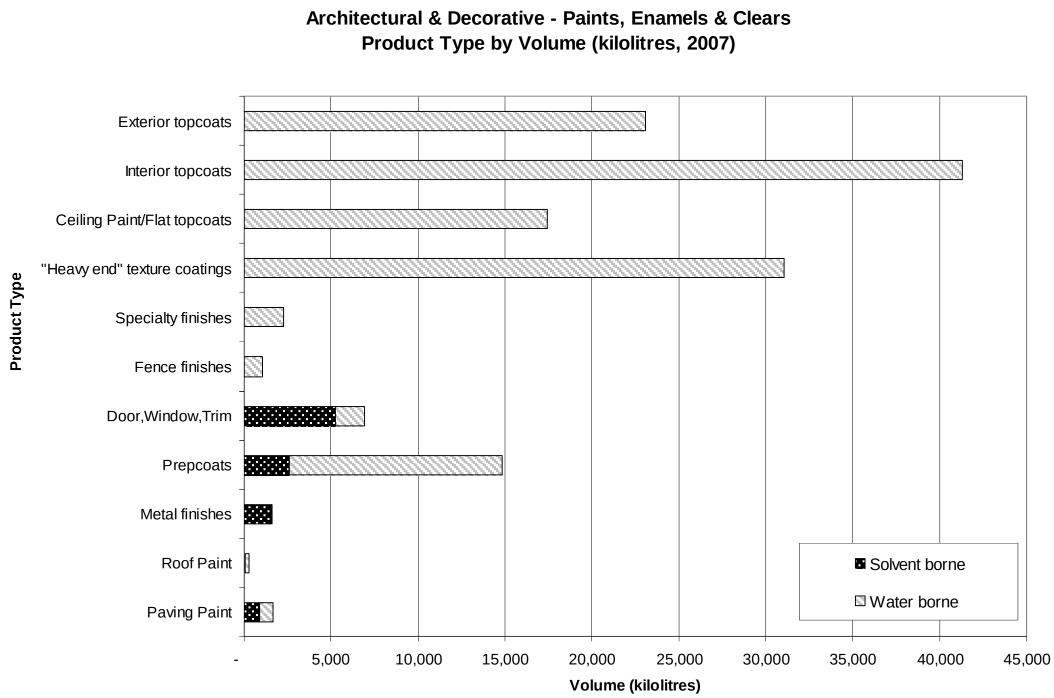


Figure 12: Architectural & Decorative Paints, Enamels & Clears – Local Sales Volumes (2007)

Architectural & Decorative Paint sales are dominated by topcoats (interior, exterior, ceiling/flat) and texture coatings, which together comprise 80% of the sales. The next most prevalent coating types are 'prepcoats' which comprise 10% of the sales and 'door, window, trim' coatings which account for 5% of sales. Whereas the topcoats and texture coatings are primarily water borne, a significant portion of solvent borne prepcoats and 'door, window, trim' coatings are still in use (18% of prepcoats and 76% of door, window, trim coatings are solvent borne).

Architectural & Decorative Wood Care sales are dominated by solvent borne coatings (76% across all product types). Decking paint accounts for almost half of the wood care sales, with 90% of the paints sold being solvent borne. Interior stains, flooring and interior clears are all primarily solvent borne (~80% solvent borne), whereas water borne coatings prevail within the prepcoats and exterior clears product types (80% to 90% water borne).

Despite the prevalence of solvent borne coatings within Architectural & Decorative Wood Care, it is noted that there is a shift towards water borne technology for certain product types, e.g. water borne technology take-up for in situ applied floor coating is given as being very strong (Dennis, 2008, Ref. **Appendix 5**).

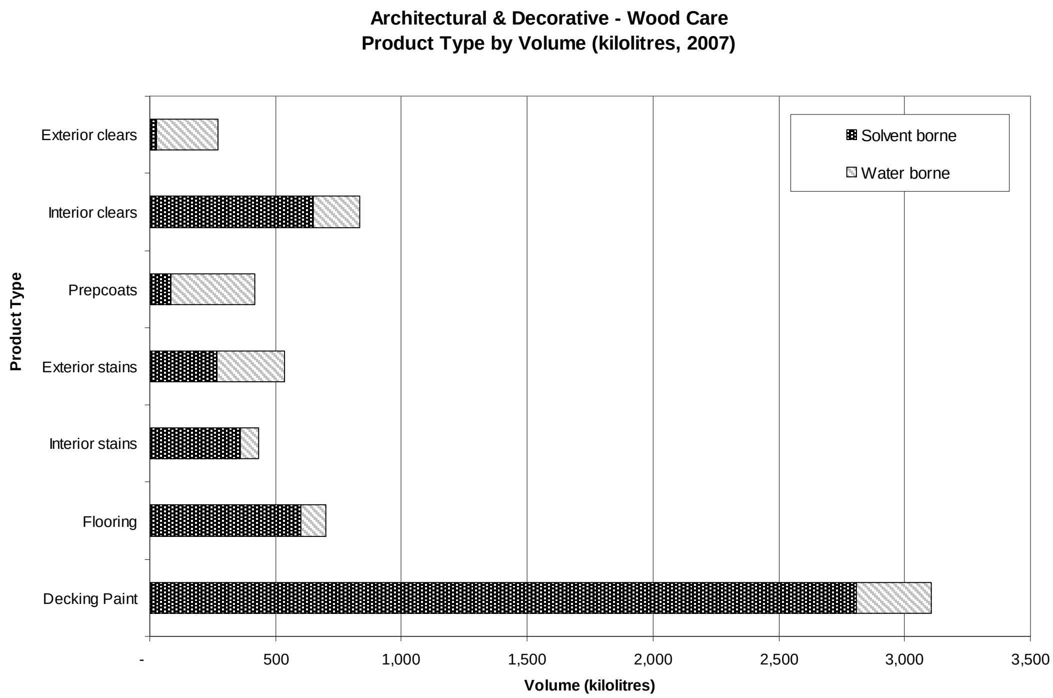


Figure 13: Architectural & Decorative Wood Care – Local Sales Volumes (2007)

4.2.3 Use of Thinners within Decorative Market

The decorative paint estimates given in **Table 13** exclude the use of solvents for cleaning and potentially also for thinning purposes. In the European Decopaints Study (2000) it was estimated that, for solvent-borne paints, the amount of thinners and cleaning agents (mainly white spirit) used and hence emitted, are likely to comprise 50% to 100% of the amount of solvents emitted though the use of these paints. For professional painters, an additional emission of only 10% was assumed.

Based on the volumes of solvent-borne paints and varnishes sold to households and trades people, as documented in **Section 4.2.2**, the use of solvents for cleaning and thinning is estimated to be in the range of 2,700 to 5,160 kilolitres. This represents an increase the amount of solvents from solvent-borne coatings usage in the order of about 40% to 70%.

4.3 Industrial Coatings

The Industrial Coatings Market Segment comprises a wide range of diverse product types. Products are often designed for user's specific applications, tailored specifically for the method of application and curing to be used, as well as for the end use of the cured coating.

Potential users of industrial coatings fall into the following main categories:

- **Transport** – Comprises users who apply coatings to new and refurbished transport, including cars, commercial vehicles, agricultural, construction and earthmoving vehicles, railway locomotives and rolling stock and aircraft. Some primers are applied by dipping, but most coatings are spray applied. Curing is generally by heating for new cars, and by air drying (often using two component paints) for refinishing or larger items.

- **Engineering** – Comprises users who coat articles and components fabricated out of metal. Powder coatings are frequently uses, as well as wet paint. Some primers are applied by dipping, but most coatings are spray applied.

- **Construction** – This sector is made up of users who coat new articles and components for use by the construction industry, notably metal and wood materials. Articles produced include cladding for walls and roofs, windows and joinery. Most coatings are spray applied or coil coating. Curing is generally by stoving for smaller items, and by air drying for larger items.

- **Furniture** – This sector comprises users who coat wooden furniture using clear or pigmented coatings. Such coatings may be applied by roller, spray or curtain and are cured by air drying, heat or UV.

- **Plastics** – The plastics sector is made up of users who coat plastic components and furniture using clear or pigmented coatings. Coatings are generally applied by spray and cured by air drying, heat or UV.

- **Packaging** – Comprises users who manufacture packaging out of metal, plastic or paper, and coat their packaging for decorative, informative and/or protective purposes. Major coatings users include can and drum makers, carton makers and plastic packaging specialists. Coatings used include paints, inks and varnishes.

- **Marine and Protective Coatings**

Industrial coating segments, distinguishable based on available production and sales data, and excluded from further assessment on the basis of their being ‘source controllable’ or insignificant sources of VOC (in the case of the latter) are Automotive OEM, Can & Coil, Flat Board and Powder Coatings. It is also noted that water borne and UV cure technology uptake has been very strong in the printing and packaging market segments for decades (Dennis, 2008).

Automotive Refinishing, Marine and Protective Coatings are for the purpose of the study dealt with as separate market segments (Ref. Sections **4.4** and **4.5**)

The remaining Industrial Coatings were grouped into the following three Product Categories:

- *Road & Runway Marking*
- *Industrial Wood Care*
- *Other Industrial*,

4.3.1 Industrial Coating Product Types

The Product Types selected for the Industrial Market Segment are listed and described in **Table 14**. These Product Types are a combination of types for which Production and Sales data are available (e.g. Road & Runway Marking; Wood Care), and in the case of 'Other Industry', product types identified as being relatively discrete by industry representatives.

Table 14: Description of Industrial Coating Product Types

Product Category:	Product Type:	Base:	Description:
Road & Runway Marking	Road & Runway Marking	S/LV	Paint used for marking on roads and runways.
Other Industrial - Finishing Coats	Alkyd	S	Coating that contains alkyd resins in the binder.
	Polyurethane 2K	S	Two component coating using polyurethane resin which has good properties of adhesion, flexibility, hardness and weathering.
	Isofree 2K	S	Two component Isocyanate-free coating
	Epoxy	S	Coatings using epoxies (extremely tough and durable synthetic resins). Highly resistant to chemicals, abrasion, moisture and alcohols. Epoxies are often used in floor finishes, paints and sealers.
	Baking enamel	LV/S	Baking Enamel typically used on pretreated or primed metal surfaces. Suitable applications include metal fabrication, shelving and cabinets.
	Acrylics	LV/S	Paints made with a synthetic binder such as acrylic, vinyl acrylic or styrene acrylic latex.
Other Industrial - Primers & Undercoats	Alkyd 1K	LV/S	One component coating using alkyd (synthetic resin).
	Polyurethane 2K	S	Two component coating using polyurethane resin which has good properties of adhesion, flexibility, hardness and weathering.
	Isofree 2K	S	Two component Isocyanate-free coating
	Vinyl etch	S	Vinyl etch primer to condition surface for subsequent painting (one or two pack).
	Epoxy	LV/S	Coatings using epoxies (extremely tough and durable synthetic resins). Highly resistant to chemicals, abrasion, moisture and alcohols. Epoxies are often used in floor finishes, paints and sealers.
	Acrylics	LV/S	Paints made with a synthetic binder such as acrylic, vinyl acrylic or styrene acrylic latex.
Industrial Wood care	Stains	S	Coating applied to wood, formulated so pigment/dye penetrates the surface to add colour without providing a surface coating. (Stains are shellacs or varnishes with colourants. The stain colours but does not obscure the grain of the surface.)
	Clears	S	Coatings applied to wood to produce a transparent film for decoration and protection of wood.
	Solid Colours	S	Opaque coating applied to wood.

S – Solvent borne; LV – Low VOC (includes water borne)
1K (one pack) – a single stage coating formulated for application without a subsequent clear coat.
2K (two pack) – coating applied in two parts and must be mixing in the correct proportions before use.

Due to the number and diverse range of users of the 'other' industrial paints, and the tailoring of coatings to suit specific users, it was not practical to distinguish coatings based on end-use functionality. A distinction was instead made between:

- *Finishing Coats*, i.e. final coat in painting system; and

- *Primers & Undercoats*, i.e. In the case of primers, coatings which ensure adhesion between the substrate and the remainder of the coatings system. In the case of undercoats or 'build coats', intermediate components of a coating system generally applied over primer or previously painted surfaces, comprising high obliterating power and ability to provide a more level surface for the top coat.

Volumes of each Industrial Product Type sold in Australia in 2007 are given in **Table 15** and illustrated in **Figure 14**.

Table 15: Industrial Product Type Volumes and % Low VOC (2007)

Market Segment	Product Category	Product Type	Volume (kilolitres)	% Low VOC
Industrial	Road & Runway	Road & Runway Marking	**4,889**	**82%**
	Other Industrial - Finishing Coats	Alkyd	2,050	0%
		Polyurethane 2K	67	0%
		Isofree 2K	150	0%
		Epoxy	99	0%
		Baking enamel	2,366	0%
		Acrylics	241	0%
		Baking enamel	585	100%
		Acrylics	464	100%
		SUBTOTAL	**6,021**	**17%**
	Other Industrial - Primers & Undercoats	Alkyd 1K	1,553	1%
		Polyurethane 2K	103	0%
		Isofree 2K	92	0%
		Vinyl Etch	526	0%
		Epoxy	6,850	83%
		Acrylics	749	78%
		SUBTOTAL	**9,874**	**64%**
	Industrial Wood care	Stains	489	0%
		Clears	2,166	0%
		Solid Colours	1,410	0%
		SUBTOTAL	**4,065**	**0%**
	Industrial Thinners	**Thinners**	**2,041**	**0%**
INDUSTRIAL COATING TOTAL			**26,890**	**42%**

Road & Runway, Finishing Coats, Primers/Undercoats and Wood care comprise 20%, 24%, 40% and 16% of Industrial Coatings sales volumes respectively.

The Road & Runway Marking and Epoxy Primer products are sold in the largest volumes, together accounting for 47% of Industry Coating sales. Low VOC products dominate both product types, accounting for 82-3% of both.

Other prominent Product Types (by volume) include Alkyd and Baking Enamel finishing coats, One Pack Alkyd Primers, and Wood Clears & Colours. These product types are predominantly comprised of solvent-borne coatings. There is however increasing user interest in other technologies in certain product ranges such as wood care (e.g. higher solids coatings and UV cured coatings) (Dennis, 2008).

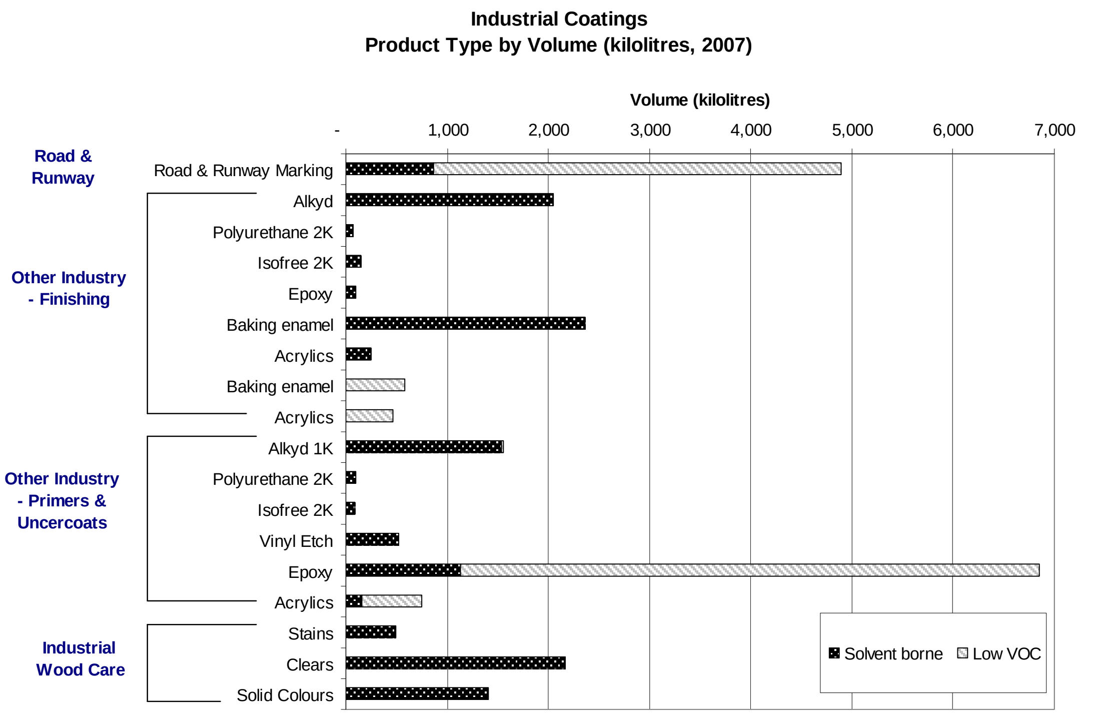


Figure 14: Industrial Coatings – Local Sales Volumes (2007) by Product Category and Type

4.4 Automotive Refinishing

Automotive refinishing refers to the application of coating products to any motor vehicle subsequent to the initial manufacturing process. Such operations may be carried out as part of vehicle repair, conservation or decoration outside of manufacturing installations.

Whereas OEM coatings can be cured at any temperature (typically up to 160℃), refinishing paints must strive to be equivalent to OEM finishes but cure at ambient, or slightly higher than ambient (e.g. 66℃) temperatures. This is nec essary so as not to damage the vehicle's upholstery, glass, wiring or plastic components.

Automotive refinishing includes operations in auto body repair shops ('smash repairers', 'body shops'), new dealer repair/paint shops, fleet operator repair/paint shops and custom-made car fabrication facilities. In Australia, a significant proportion of refinishing is undertaken in body shops of which there are an estimated 4,500 currently in operation nationally. There is an increasing trend towards rationalisation and aggregation within the smash repair sector. It was estimated that the number of body shops will reduce to 3000 in 3 to 5 years time due primarily to pressure from insurance companies for greater efficiency and improvements in anti-collision road technology.

The Australian Automotive Refinish market is primarily supplied by global paint companies such as PPG, BASF Coatings and Akzo Nobel, with major product platforms formulated to meet either EU or US regulation.

Refinishing work typically includes structural repair, surface preparation and painting. Surface preparation includes grinding the paint off sheet metal, and applying, smoothing, shaping and sanding polyester resin body fillers. Painting involves matching paint colours, mixing paint formulations and painting the repaired area using custom and conventional painting techniques.

Workers in smash repair shops can potentially be exposed to a wide range of air contaminants. Automobile painters can be exposed to organic solvents, hardeners that may contain isocyanate resins, and pigments that may contain toxic components.

Painting and coatings are comprised of binders, pigments, solvents and various additives. Conventional coatings typically comprise three major components: (i) a pigment for colour, (ii) a polymer that acts as a binder, and (iii) a liquid carrier, generally a solvent. In some coating formulations, the solvent portion can account for two-thirds of the coating. Solvents provide proper viscosity, flow and drying characteristics.

Automotive refinishing coatings cover a range of product types including pre-treatments, primers, sealers, pre-coats, speciality coatings and various topcoats. Topcoats can be pigmented (colour coats) or clear (clear coats). Pigmented topcoats can provide a high gloss (“single stage”) or can be subsequently covered with a clear coat which provides gloss and protection (“base coat”).

Topcoats provide decorative (colour and gloss) effects and durability (resistance to weathering and UV radiation) and are also essential in resisting physical damage (scratch, mar, chip) and chemical damage (salt, solvent and acid resistance).

4.4.1 Automotive Refinishing Coating Product Types

Product Types with Thinners and Hardeners reported Separately

‘Product Types’ for the Automotive Refinishing Segment which have previously been defined by the APMF and are routinely used for information collation/reporting by the industry are given in **Table 16**.

From the ‘product types’ in **Table 16** it is apparent that certain of the types, namely 1K-thinners, 2-K thinners and 2K-hardeners (isocyanates and other), whilst sold separately represent constituents within final end use products rather than being products themselves. Thinners and harders, whilst being purchased separately by end users, are mixing within primers, basecoats and topcoats, prior to application. The ratio of thinners and hardeners mixed with paints is user-specific making it impossible to exactly apportion these substances to derive final end use product types and volumes.

Products generally comprise paints (primers, topcoats), lacquers, enamels, adhesives (hardeners) and thinners. A distinction is generally made between one-pack (1K, single stage, one component) and two-pack (2K, two stage, two component) products.

A single-stage coating formulated for application without a subsequent clear coat. Single-stage coatings include single-stage metallic/iridescent coatings. A two-pack system refers to a coating which is supplied in two parts and must be mixed in the correct proportions before use in order to cure.

Single pack components may include thinner and other additives to adjust properties such as drying times, gloss, texture or flexibility. Two pack, chemically curing, product components additionally include hardener, activator or catalyst.

Table 16: Description of Automotive Refinishing Coating Product Types

Product Category:	Product Type:	Base:	Description:
Refinishing	1K-Primers	S/LV	One component coating designed for application to bare metal or existing finishes to provide corrosion protection prior to application of a primer surfacer.
	1K-Lacquers-Clear	S/ LV	One component clear coating; transparent coating designed to provide final gloss and resistance properties of the coating system.
	1K – Lacquers – Colour	S/ LV	One component opaque coating (dries to hard, glossy finish).
	1K – Synthetic air dry enamels	S	One component enamel dried by exposure to air at normal (ambient) temperature
	1K-Thinners	S	Liquid, volatile under specified drying conditions, added to a coating material to influence properties, primarily the viscosity.
	2K – Primers – Urethane	S	Two component urethane coating; containing an isocyanate complex. They form tough, hard, flexible, chemical resistant films.
	2K – Primers – Others	S/ LV	Two component primers other than urethane coatings.
	2K – Basecoats	S/ LV	Two component basecoats. (A base coat is a colour coat applied to a surface – it has low gloss and no protection from U.V. light and must be clear coated to achieve longevity and a glossy appearance.)
	2K – Topcoats – Clears	S/ LV	Two component clear topcoat. (A topcoat is the last coat applied in a coating system. Usually applied over a primer, undercoat or surfacers.)
	2K – Topcoats – Colour	S/ LV	Two component opaque topcoat. (A topcoat is the last coat applied in a coating system. Usually applied over a primer, undercoat or surfacers.)
	2K – Hardeners – Isocyanates	S/ LV	Two component hardener with isocyanates as component in hardener (used in top coats, notably clear coats)
	2K – Hardeners – Other	S	Two component hardeners excluding isocyanates
	2K – Thinners	S/ LV	Liquid, volatile under specified drying conditions, added to a coating material to influence properties, primarily the viscosity.
	Others (e.g. Cleaners, Enamels)	S/ LV	

S – Solvent borne; LV – Low VOC (includes water borne)
1K (one pack) – a single stage coating formulated for application without a subsequent clear coat.
2K (two pack) – coating applied in two parts and must be mixing in the correct proportions before use.

Volumes of each Automotive Refinish Product Type sold in Australia in 2007 are given in **Table 17** and illustrated in **Figure 15**. The local automotive refinish market is estimated to comprise about 10,167 kilolitres/annum, with low VOC coatings constituting less than 10% of the market.

Table 17: Automotive Refinishing Product Type Volumes and % Low VOC with hardeners and thinners reported separately (2007)

Market Segment	Product Category	Product Type	Volume (kilolitres)	% Low VOC
Automotive	Automotive Refinishing	1K - Synthetic air dry enamels	423	0%
		1K-Thinners	1,777	0%
		2K - Primers - Urethane	487	0%
		2K - Hardeners - Other	101	0%
		1K-Primers	388	5%
		1K-Lacquers-Clear	101	4%
		1K - Lacquers - Colour	414	3%
		2K - Primers - Others	361	16%
		2K - Basecoats	1,142	13%
		2K - Topcoats - Clears	884	17%
		2K - Topcoats - Colour	1,076	5%
		2K - Hardeners - Isocyanates	965	14%
		2K - Thinners	1,539	14%
		Others (e.g. Cleaners, Enamels)	509	4%
	AUTOMOTIVE REFINISHING TOTAL		**10,167**	**8**%

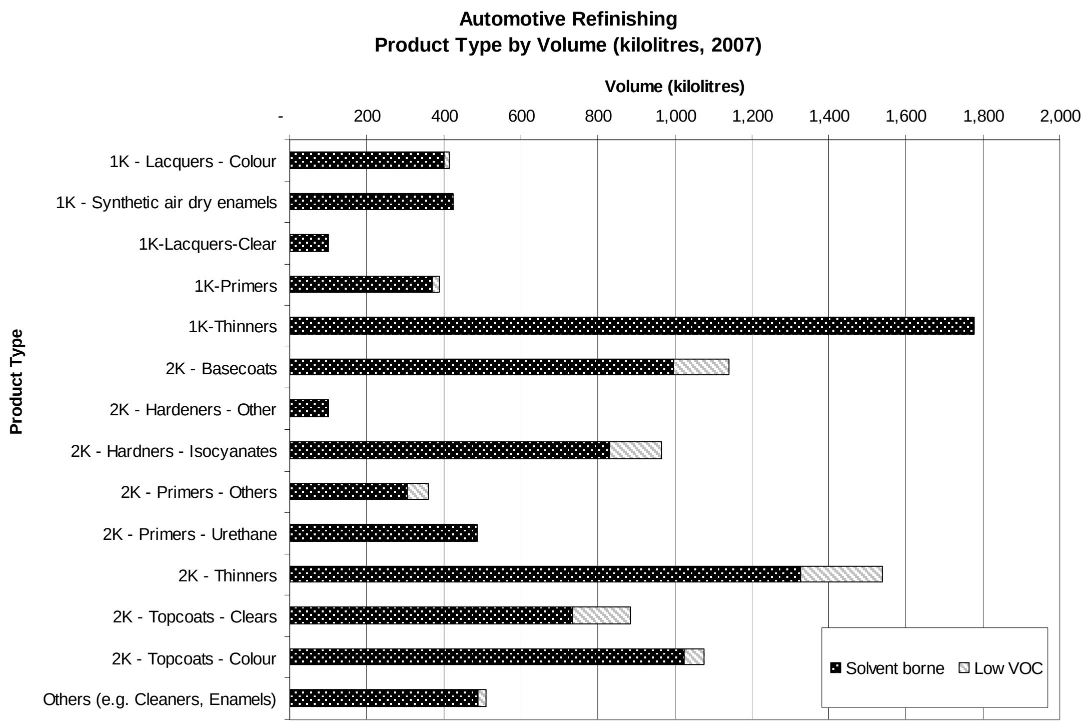


Figure 15: Automotive Refinishing Coatings – Local Sales Volumes (2007) by Product Category and Type (thinners and hardeners reported separately)

Product Types incorporating Thinners and Hardeners

To adequately apportion the thinners and hardeners to end use coating product types, consultation was undertaken with PPG personnel; PPG representing a key player in the automotive refinish sector. Based on the knowledge of such personnel on the end use application of automotive refinish coatings, thinners and hardeners were apportioned between automotive refinishing product types (*personal communication* Paul Addeney and Joe Lister, PPG, December 2008).

To improve the apportionment of thinners and hardeners, certain original Product Types (as currently reported by industry and reflected in **Table 16**) were split into two separate product types, as follows (*personal communication* Paul Addeney and Joe Lister, PPG, December 2008):

- 1K-Synthetic air dry enamels (423 kL) was split into 1K-Synthetic air dry enamels Primers (200 kL) and 1K-Synthetic air dry enamels Topcoats (223 kL).
- 1K-Primers (388 kL)was split between 1K-Primers (288 kL) and Plastics Adhesion Promoters (100 kL).

- 1K-Lacquers-Colour (414 kL) was allocated to Basecoat Effect (207 kL) and Single Stage (207 kL).
- 2K-Primers-Others (361 kL) was split between Etch Primers (180 kL) and Other Primers (181 kL).

The volumes of thinners and hardeners apportioned to the extended list of Product Types are given in **Table 18**, and illustrated in **Figure 16**.

When thinners and hardeners are included in automotive refinish products, one-pack coatings are estimated to account for 26% of sales and comprise mainly solvent borne coatings (97%). Two-pack coatings make up 69% of sales, with 90% being solvent borne coatings.

Table 18: Apportionment of Thinners and Hardeners between Automotive Refinish Coatings Product Types (based on information received from Paul Addeney and Joe Lister, PPG, December 2008)

Product Type	Total Volume, excluding Thinners & Hardeners (kL)	1K-thinners (kL)	2K-thinners (kL)	2K - Hardeners - Isocyanates (kL)	2K - Hardeners - Other (kL)	Total Volume, including Thinners & Hardeners (kL)
1K - Synthetic air dry enamels (Primers)	200	60				260
1K - Synthetic air dry enamels (Topcoats)	223	67				290
1K-Primers	288	432				720
Plastics Adhesion Promoters	100					100
1K-Lacquers-Clear	101	152				253
1K - Lacquers- Colour Basecoat Effect	207	311				518
1K - Lacquers - Colour Single Stage	207	310				517
2K Etch Primer	180		180			360
2K Epoxy Or Other Primer (non PU)	181			101		282
2K - Primers - Urethane	487		130		132	749
2K - Basecoats	1,142		1,142			2,284
2K - Topcoats - Clears	884		236		374	1,494
2K - Topcoats - Colour	1,076		296		459	1,831
Others (e.g. Cleaners, Enamels)	509					509
Total	**5,785**	**1,332**	**1,984**	**101**	**965**	**10,167**

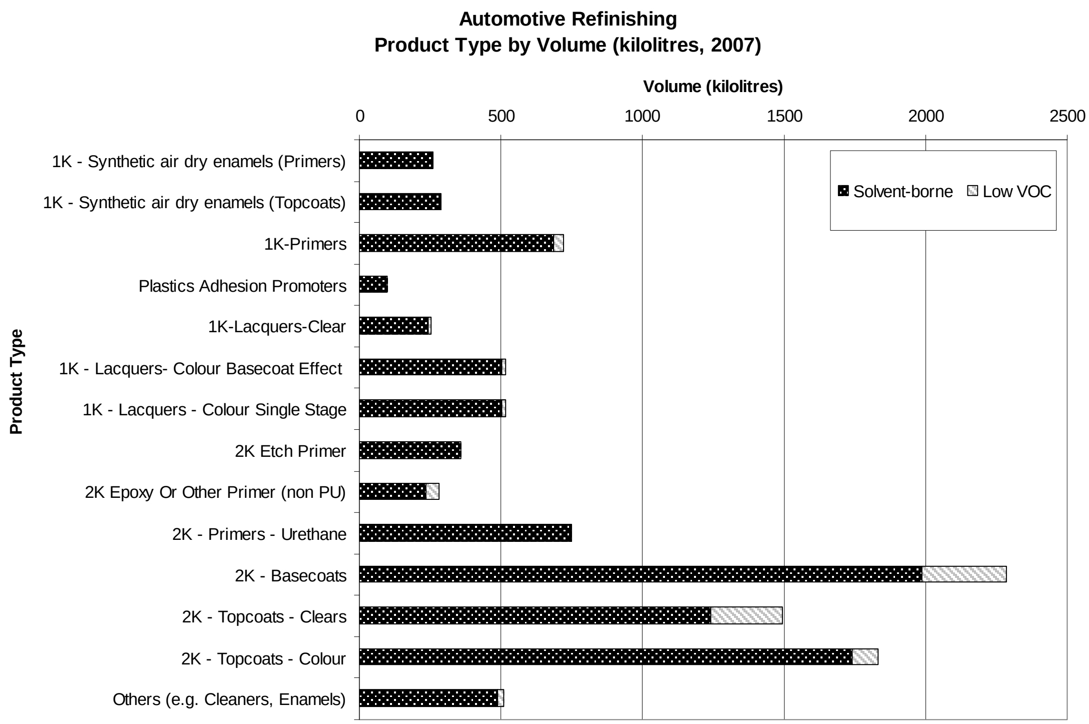


Figure 16: Automotive Refinishing Coatings – Local Sales Volumes (2007) by Product Category and Type (including thinners and hardeners to reflect End Use Products)

4.5 Heavy Duty Coatings

The Heavy Duty Segment comprises Marine, Yacht/Pleasure Craft and Protective Coating Categories.

4.5.1 Marine and Pleasure Craft

The marine paint market comprises users who apply paint above and below the waterline of ships and boats. The market can be split into sectors based on the size of the vessel being painted. Large passenger, cargo and naval vessels which are often international in their movements and need to be dry docked for major painting, are on the top end of the scale. In the middle are smaller boats, such as fishing boats, which can be hauled out of the water on a slipway. At the lower end of the scale are leisure craft, maintained by their owners or by specialist shipyards.

Based on inputs received from industry representatives within the marine sector, it was decided to differentiate between ‘marine’ and ‘yacht & leisure craft’ product categories. Leisure craft fall into the ‘yacht’ category with all other boats and ships being included under ‘marine’.

It is noted that the proposed Hong Kong VOC regulations for the marine sector are categorised into marine and pleasure craft categories. Marine coatings are defined as coatings applied by any means to ships, boats, and their appurtenances, and to buoys, and their drilling rigs intended for the marine environment. The marine category excludes any coatings applied on any pleasure crafts or their associated parts and components, which forms a separate category.

The Commercial Marine market is primarily supplied by global paint companies that have major product platforms that have been formulated to meet EU or US regulation. The specification and user requirements for marine coatings are predominately global in nature. Underwater systems, in particular, have performance testing and regulatory requirements that tend to preclude rapid product changes.

Yacht and Pleasure Craft coatings are typically applied at professional applicator facilities and by DIY owners. Technology used in this category derives in part from Commercial Marine (global) and products from other market segments (protective coatings, industrial wood care).

4.5.2 Protective Coatings

The Protective Coatings market is made up of users who apply protective and anti-corrosive coatings, usually to steel and concrete structures. Most users are highly specialist painting contractors working on structures where the standard of protection required is very high and access is often difficult. Such structures include bridges, heavy industrial plants, offshore drilling rigs and production platforms. Coatings are applied by spray whenever possible, and by roller or brush when it is not.

The Protective Coatings market in Australia is primarily supplied by global paint companies that have major product platforms that have been formulated to meet future EU or current US regulation.

4.5.3 Heavy Duty Product Types and Volumes

The Product Types selected for each of these product categories are listed and described in **Table 19**. Such product types are based on classifications used within the industry to reflect coating uses.

Table 19: Description of Heavy Duty Coating Product Types

Product Category:	Product Type:	Base:	Description:
Marine	Antifouling	S	Coating used to protect vessels from attaching organisms.
	Foul Release	S	(New addition to the anti-fouling paint family.) Coating where the mechanism for effective anti-fouling is based on the low free surface energy of the coating surface. Fouling organisms find the surface unattractive on which to settle. Biocides are not
	General	S/LV	
	Primer/Surfacer	S	Coating applied to bare metal or existing finishes to provide corrosion protection.
	Single Pack - Protection of Steel	S	Single component coating for steel protection.

Table 19: Description of Heavy Duty Coating Product Types

Product Category:	Product Type:	Base:	Description:
	Tie-Coat	S	Paint applied to a previous coat to improve the adhesion of subsequent coats or to prevent other surface defects e.g. bubbling of a subsequent coating.
	Topcoat - Multi Component	S	Multi component topcoat. (A topcoat is the last coat applied in a coating system.)
	Topcoat - One Component	S	One component topcoat. (A topcoat is the last coat applied in a coating system.)
	Two Pack Epoxy - Protection of Steel	S	Two component coatings using epoxies (extremely tough and durable synthetic resins). Highly resistant to chemicals, abrasion, moisture and alcohols.
	Two Pack Epoxy Filler	S/ LV	Two component material using epoxies (as resin), used to build up or fill depressions and imperfections on the surface.
	Wash Primer	S	Paint containing phosphoric acid which gives an etching effect for use on aluminium and galvanized steel to improve the adhesion of the subsequent layer of paint.
	Zinc Rich	S	Paints containing large proportions of metallic zinc in the dry film, giving extremely efficient anticorrosive properties due to the cathodic protection effect of the zinc.
	Extreme High Gloss Coating	S	A coating which, when tested by the American Society for Testing Material (ASTM) Method D-523 adopted in 1980, shows a reflectance of 75 percent or more on a 60o meter.
Yacht	Antifouling	S	Coating used to protect vessels from attaching organisms.
	Clear Wood Finish - Sealer	S	Paint used to seal the substrate or previous coats and prevent interaction between subsequent coats applied
	Clear Wood Finish - Varnish	S	Coatings applied to wood to produce a transparent film for decoration and protection of wood.
	Foul Release	S	Refer to definition given under Marine
	General	S/ LV	
	Primer/Surfacer	S	Refer to definition given under Marine
	Single Pack - Protection of Steel	S	Refer to definition given under Marine
	Tie-Coat	S	Refer to definition given under Marine
	Topcoat - Multi Component	S	Refer to definition given under Marine
	Topcoat - One Component	S	Refer to definition given under Marine
	Two Pack Epoxy - Protection of Steel	S	Refer to definition given under Marine
	Two Pack Epoxy Filler	S	Refer to definition given under Marine
	Wash Primer	S	Refer to definition given under Marine
	Extreme High Gloss Coating	S	Refer to definition given under Marine
Protective Coatings	Intumescent		Paint that when heated by a flame swells to form an insulating char. Insulates substrate from surrounding heat and provides extra time for evacuation of a building, prior to structural failure of the steel.
	General	S/ LV	
	Primer/Surfacer	S	Refer to definition given under Marine
	Single Pack - Protection of Steel	S	Refer to definition given under Marine
	Tie-Coat	S	Refer to definition given under Marine
	Topcoat - Multi Component	S	Refer to definition given under Marine
	Topcoat - One Component	S	Refer to definition given under Marine
	Two Pack Epoxy - Protection of Steel	S	Refer to definition given under Marine
	Two Pack Epoxy Filler	S	Refer to definition given under Marine
	Wash Primer	S	Refer to definition given under Marine
	Zinc Rich	S	Refer to definition given under Marine
Other	Thinners	S	Liquid, volatile under specified drying conditions, added to a coating material to influence properties, primarily the viscosity.

S – Solvent borne; LV – Low VOC

Volumes of Heavy Duty Product Types sold in Australia in 2007 are given in **Table 20** and illustrated in **Figure 17, Figure 18** and **Figure 19** for the Marine, Yacht/Pleasure Craft and Protective Coating Categories respectively. No data were received for Foul Release and Intumescent Product Types, these data having being specified as confidential.

Table 20: Heavy Duty Product Type Volumes and % Low VOC (2007)

Market Segment	Product Category	Product Type	Volume (kilolitres)	% Low VOC
Heavy Duty	Marine	Antifouling	365	~0%
		Foul Release	ND	ND
		Primer/Surfacer	71	~0%
		Single Pack - Protection of Steel	19	~0%
		Tie-Coat	100	~0%
		Topcoat - Multi Component	120	~0%
		Topcoat - One Component	108	~0%
		Two Pack Epoxy - Protection of Steel	201	~0%
		Wash Primer	0.8	~0%
		Zinc Rich	17	~0%
		Extreme High Gloss Coating	1.0	~0%
		General	8.1	96%
		Two Pack Epoxy Filler	0.5	28%
		SUB-TOTAL MARINE	**1,012**	**~1 %**
	Yacht & Pleasure Craft	Antifouling	208	~0%
		Clear Wood Finish - Sealer	20	~0%
		Clear Wood Finish - Varnish	20	~0%
		Foul Release	ND	ND
		Primer/Surfacer	187	~0%
		Single Pack - Protection of Steel	7	~0%
		Tie-Coat	21	~0%
		Topcoat - Multi Component	18	~0%
		Topcoat - One Component	20	~0%
		Two Pack Epoxy - Protection of Steel	5	~0%
		Two Pack Epoxy Filler	16	~0%
		Wash Primer	39	~0%
		Extreme High Gloss Coating	54	~0%
		General	39	99%
		SUB-TOTAL YACHT	**653**	**6%**
	Protective Coatings	Intumescent	ND	ND
		General	58	86%
		Primer/Surfacer	1,066	~0%
		Single Pack - Protection of Steel	617	~0%
		Tie-Coat	69	~0%
		Topcoat - Multi Component	1,656	~0%
		Topcoat - One Component	718	~0%
		Two Pack Epoxy - Protection of Steel	4,165	~0%
		Two Pack Epoxy Filler	47	~0%
		Wash Primer	3	~0%
		Zinc Rich	1,516	~0%
		SUB-TOTAL PC	**9,916**	1%
	Other	**Thinners (total)**	**1,650**	**0%**
HEAVY DUTY COATINGS TOTAL			**13,231**	**~1%**

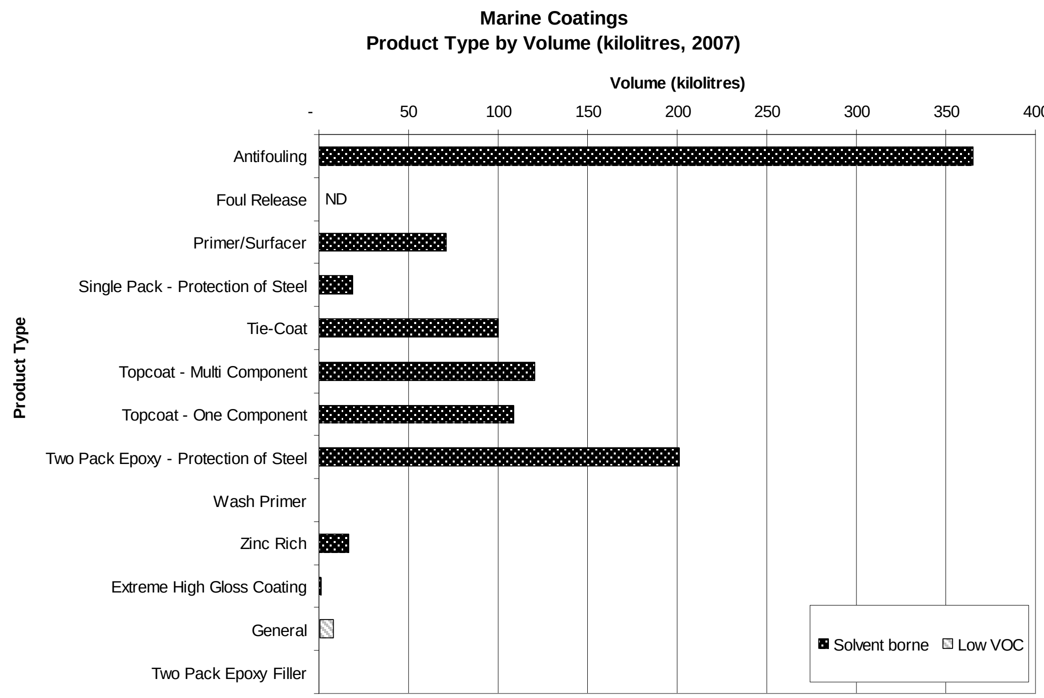


Figure 17: Marine Coatings – Local Sales Volumes (2007) by Product Type

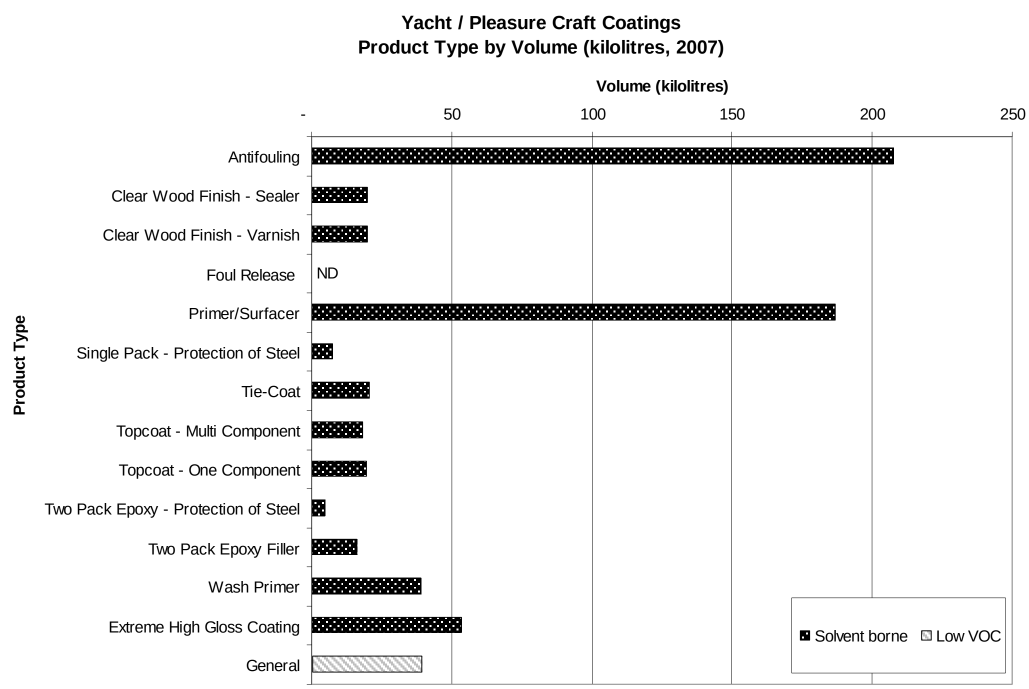


Figure 18: Yacht Coatings – Local Sales Volumes (2007) by Product Type

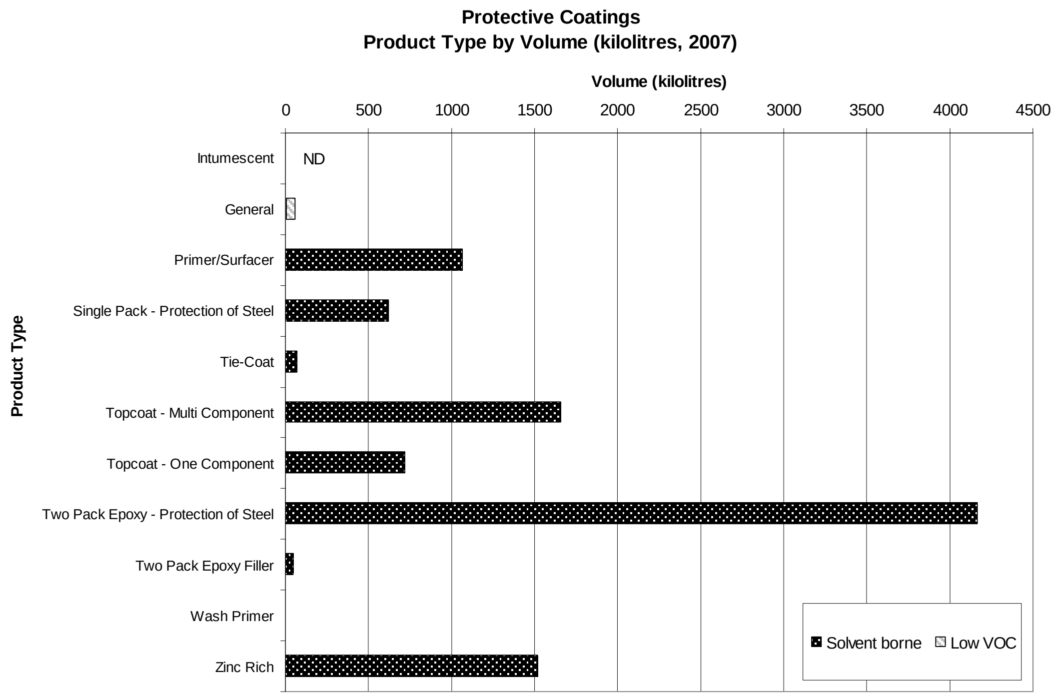


Figure 19: Protective Coatings – Local Sales Volumes (2007) by Product Type

5 VOC Emissions and Ozone Creation Potentials

The relative significance of Market Segments, Product Categories and individual Product Types was assessed on the basis of their VOC content (emissions) and the potential of these VOCs to produce smog (i.e. reactivity-weighted VOC content). This required the specification of a VOC definition that would facilitate comparative assessments and evaluations against local and international emission limits, and the selection of a scheme for estimating smog formation potentials.

The method applied in estimating total and reactivity-weighted VOCs is described in **Section 5.1**, and the ranking of Market Segments, Product Categories and Types based on their unit (g/litre) and volume-weighted VOC contents presented in subsequent subsections. The comparison of VOC contents to local and international VOC limits is covered in **Section 6**.

5.1 Total VOC and Reactivity-weighted VOC Estimation

5.1.1 VOC Definition and VOC Content Quantification Methods

The term VOC is widely used in environmental and occupational health policy, but is frequently defined differently for the purposes of such policies.

Within the context of surface coatings, definitions of VOCs range from all organic solvents (and co-solvents) to VOCs being described as compounds with specific vapour pressures, boiling points or photochemical reactivity potential.

VOC definitions which are pertinent to the current study are given as follows:

- APAS D181 defines VOCs as organic compounds in paint formulations (either as individual ingredients of the formula or a part of e.g. an intermediate raw material) that have:

  a) a vapour pressure >0.01 mm Hg at 21℃, or

  b) an initial boiling point <250℃ measured at a standard pressure of 101.3 kPa.

  APAS D181 excludes acetone due to this compounds not participating in smog forming processes.

- The NPI defines VOCs as any chemical compound based on carbon chains or rings with a vapour pressure greater than 2 mm Hg at 25℃. These compounds may contain hydrogen, oxygen, nitrogen and other elements. Substances that are specifically excluded are: carbon dioxide, carbon monoxide, carbonic acid, carbonate salts, metallic carbides and methane.
- EU Directive 2004/42/CE specifies that VOC means any organic compound having an initial boiling point less than or equal to 250℃ measured at a standard pressure of 101.3 kPa.
- In the US, VOC is given as any organic compound that participates in atmospheric photochemical reactions, that is, any organic compound other than those which are

specifically designated as having negligible photochemical reactivity and declared as being exempt. This definition is also adoption in Canada and Hong Kong, with a number of exempt solvents listed; over 30 compounds in the case of Hong Kong.

The quantification of **VOC content** within coatings are also treated differently:

- APAS D181 specifies that VOC content of a paint or coating be determine by one of more of the following methods:
  - using raw material supplier's data that corresponds with its definition of VOC, by calculation for each of the raw materials and individual ingredients in any intermediate raw materials, the total VOC content of the formula; or
  - Determined experimentally in accordance with ASTM D3960. By determining the weight percent non volatile content (and hence the volatile content) by ASTM D2369 (60 minutes at 110±5℃) and converting to g/L (as p er ASTM D3960).

  APAS further requires that the VOC content be expressed to include any thinning solvent recommended as mandatory on the label or data sheet for the method of application proposed, but tinter additions are excluded from VOC calculations.

- NPI methods for quantification of the VOC content of coatings include the use of information from Material Safety Data Sheets for raw, intermediate and final materials.
- EU Directive 2004/42/CE specifies that VOC content means the mass of the VOCs, expressed in grams/litre (g/l), in the formulation of the product in its ready to use condition. The mass of VOCs in a given product which react chemically during drying to form part of the coating shall not be considered part of the VOC content.
- The primary method for determining the VOC content in the US (and Canada) is Method 24 of Appendix A-7, Part 60, Chapter I of Title 40 of the *Code of Federal Regulations* of the USA, entitled *Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings*.(4). Under US regulations, VOC content must be calculated per litre of coating thinned to the manufacturer's maximum recommendation, excluding the volume of any water, exempt compounds or colorant added to the tint bases.

The APAS and EU definitions for VOCs are very similar. The main differences being that APAS has an additional vapour pressure provision and specifically excludes acetone. In terms of quantifying the VOC content of coatings, the APAS and EU methods are again similar, both requiring that the VOC contents be established for coating products in their 'ready to use' condition. The US, Canadian and Hong Kong approach requires that the water content of the product be removed prior to establishing the VOC content (i.e. undiluted coating, not ready for use).

To best meet the objectives of the study, the APAS/EU VOC definition was adopted. The APAS (EU) VOC definition was generally also preferred by industry representatives, given

4 The US-EPA Method 24 is widely accepted not to be reliable for the analysis of low VOC water-borne coatings, nor is it suitable for determining the VOC content of solvent-borne coatings with high levels of 'exempt compounds. The measurement of multi-component coatings, reactive diluent-containing coatings, high solids coatings and low solids coatings using this method are also of concern. The California Air Resources Board (CARB) has commissioned a study to improve the test method, with study conclusion by the end of 2008.

that many of them already had VOC contents calculated for their products based on this definition.

The VOC data provided by most industry players are known to have been calculated using a mass balance approach using information on the VOC content of raw and intermediate materials used in the coating composition (as per the first APAS method). This approach was also applied by ENVIRON in calculating the VOC contents of product types for which detailed solvent composition data were obtained during Survey 2.

VOC content data derived experimentally using the second APAS method was also received from the APAS Executive Officer (Ref. **Section 5**).

5.1.2 VOC Content Data Accuracy

It was not always possible, due primarily to confidentiality constraints, to check the VOC content calculations provided by industry players. Inaccurate data sets were however identified and additional information obtained for their correction based on:

- comparisons of VOC contents for similar product types with published values;
- comparisons of VOC contents across industry players;
- workshopping of data sets with Industry Focus Groups; and
- evaluation of the VOC contents provided by industry on the basis of the VOC contents calculated based on the detailed solvents data received during Survey 2.

Further information on data inaccuracies identified and subsequent correction made is provided in **Section 2.4.4**.

5.1.3 VOC Emission Estimation

Surface coating operations emit VOCs through evaporation of the paint carrier, thinner or solvent used to facilitate the application of the coating. Most, if not all, of the volatile portion of the coating evaporates during or following application (NPI, 1999).

For the purpose of the current study, the VOC content of coating products inventoried, with the exception of those defined as ‘source controllable coatings’, were assumed equivalent to the VOC emission potentials of such coatings.

Can & coil, flat board and automotive OEM coating products were classified as ‘source controllable coatings’ and the VOC content within such products excluded from the VOC emission estimates. These coatings are primarily applied in large industrial facilities where emissions either are (or could be) routinely regulated under license and VOC abatement measures implemented.

In the quantification of VOC emissions from the Surface Coating Sector, the following study assumptions are of note:

- A conservative approach was adopted in terms of excluding ‘source controllable coating’ usage.

- A range of source based control measures are, for example, available for implementation at ‘smash repair’ operations. Due to effective measures not currently being widely implemented by such operations, and given concerns regarding the cost effectiveness of measures given the size of operations, the Automotive Refinishing Product Category was retained.
- Protective coatings, marine coatings and various industrial coatings are applied in a range of environments as describe previously, with source-based control measures not always feasible. These coating categories were therefore retained for emission estimation purposes.
- All VOCs contained within coating products are assumed to be emitted, with not provision made for VOCs in a given product which may react chemically during the drying process to form part of the coating.

Based on the approach adopted, the VOC emission estimates may be expected to overestimate VOC emissions. The margin of error is estimated to be of the order of 15%.

5.1.4 Relative Photochemical Reactivity Estimation

The impact on ozone formation by a specific source is not directly proportional to the amount of VOC emitted by that source. A major determinant of the ozone forming potential is the reactivity of the compound or compound mixture emitted. Reactivity can be viewed as the propensity for a compound to form ozone, and this propensity varies dramatically between compounds and between environments (Carter, 1991).

Although the contribution made by any individual VOC to photochemical ozone formation depends crucially on environmental conditions, the contributions made by one VOC relative to another, or pairs or groups of VOCs relative to each other, are much less variable. Ethane is, for example, relatively non-reactive compared with most VOCs and toluene is relatively more highly reactive, under most conditions.

The relative rankings of VOCs in a quantitative table is termed a *reactivity* scale or scale of *ozone formation potential*. The most widely publicized and applied scales are the Maximum Incremental Reactivity (MIR) scale, developed by Carter and co-workers to assess ozone formation over periods of up to a day in urban scenarios in the USA (e.g. Carter, 1994, 1995; Carter et al., 1995), and the Photochemical Ozone Creation Potential (POCP) scale, developed by Derwent and co-workers to investigate regional scale ozone formation in northwest Europe (e.g. Derwent and Jenkin, 1991; Derwent *et al.*, 1996, 1998). The relative rankings of VOCs on these scales are very similar.

For the purpose of the current study reference was made to the Carter MIR Scale. The MIR scale is expressed as grams of ozone formed per gram of organic compound reacted. Each compound is assigned an individual MIR value, which enables the reactivities of different compounds to be compared quantitatively.

The Carter MIR scale was found to be the most comprehensive in terms of the number of compounds relevant to coatings covered. The scale is also already in use within Australia, having been used by the NSW DECC in the development of its Metropolitan Emissions Inventory and being in use by some of the industry players contributing to the study.

The latest MIR values (Carter, 2007) were applied in the study. The higher the MIR value, given in grams of ozone per gram of VOC, the more ozone a VOC has the potential to form in the atmosphere.

Application of Carter MIR Scale

During Survey 2, detailed solvent content data was obtained from key industry players for each Coating Product Type within the Automotive Refinishing, Industrial (Finishing Coats, Primers & Undercoats, Road & Runway Marking, Industrial Wood Care) and Architectural & Decorative Wood Care Product Categories.

On a company-by-company basis, the volume of each solvent contained within each product type was multiplied by its relevant MIR value to estimate the ozone formation potential. Ozone formation potentials were then summed across solvents to calculate the total ozone formation potential (and overall MIR) for the product type.

Ozone formation potentials were also calculated as a volume weighted average across all companies for each product type to provide the best estimate of the overall reactivity of that product type relative to others.

The calculation of the ozone formation potential (or reactivity-weighted VOCs) for product types within the Architectural & Decorative – Paint, Enamel & Clear Product Category was based on the data provided in Survey 1. Industry operators within this market agreed that the total VOC content reported for individual product types during Survey 1 could be assumed to comprise primarily propylene glycol in the case of all water-borne paints, and as mineral turpentine (1 part) and white spirits (2 parts) for all solvent-borne products.
The reactivity factor for propylene glycol was therefore applied to the VOC content reported in the initial survey for all water-borne products. Reactivity factors for mineral turpentine and white spirits were applied (in the relevant parts) the VOC content reported for solvent-borne coatings.

Approximately 70 solvents were reported on across all Product Categories for which solvent data were available. The MIR values for these compounds ranged from 0.35 (acetone) to 11.5 (1,3,5-trimethyl benzene), with an average (not volume weighted) MIR of 2.84 and a medium MIR of 2.34.

Most of the MIR values were obtained from the Carter (2007) scales. In the case of certain mixtures and trade name solvents for which no MIRs are available in the literature, MIRs were provided by the suppliers of such solvents. Notably MIRs for the following solvents were provided by Rod Boyd (Solvents Technical Manager – S.E. Asia, Shell Chemicals):

	MIR Value
Mineral Turps	3.8
SHELLSOL D60	0.9
SHELLSOL A100	7.5
SHELLSOL A150	8.1
White Spirits	2.0
SHELL X95	2.0

SHELL X55	1.6
SHELL X3B	2.8

The MIR values used in the study are given in **Appendix 6**. MIR values could not be obtained or derived for five of the solvents reported on, namely:

Compound:	**CAS No.**
bis-(1,2,2,6,6-pentamethyl-4-piperidinyl)-sebacate	41556-26-7
ethoxy propyl acetate	54839-24-6
hydroxxyphenyl-alkylbenzotriazole	127519-17-9
methyl 1,2,2,6,6, pentamethyl-4-piperrridyl sebacate	82919-37-7
trizincbis (orthophosphate)	7779-90-0

Sensitivity analyses were undertaken to assess the significance of omitting these compounds from the reactivity calculations. Due to these compounds being used in a limited number of product types, and only being present in relatively small quantities, the omission of these compounds was found to be negligible.

Assessing Relative Reactivities for Marine & Protective Coatings

Key industry players within the Heavy Duty Market Segment indicated that detailed solvent information could not be provided within the timeframe of the project. It was however noted that reactivity calculations based on detailed solvent compositions of Product Types within the Heavy Duty Segment had been previously undertaken by International Paints.

International Paints offered to provide MIR information (using the Carter MIR scale), based on their product formulations, for potential application to the Total VOC contents reported for such Product Types during Survey 1. Despite differences in company-specific formulations it was agreed by the Marine & Protective Coatings Focus Group that the solvent types used were likely to be sufficiently comparable to give a coarse indication of reactivity-weighted VOCs.

Hempel, PPG, Wattyl and International Paint provided production volumes and total VOC contents for each product type within the Heavy Duty Market Segment. International Paint provided information for each product type on the proportion of the total VOC content which fell within MIR ranges of less than and greater than 4. This facilitated reactivity comparisons between product types within the Heavy Duty Segment.

To permit comparisons between Heavy Duty coatings and coatings within other sector, the portion of the total VOCs with MIRs given as being <4 range were assumed to be 0.35, and the portion of VOCs with MIRs given as being >4 assumed to be 4.

5.2 VOC Emissions & Ozone Formation Potentials

Total VOCs contained within all surface coating products sold in Australia, including coatings used within potentially controlled environments, was estimated to be 51,234 tonnes. Not all of the estimated VOCs is however expected to be emitted to the atmosphere, due primarily to industrial controls being in place. If the VOC content of 'source controllable coatings' is excluded, total VOCs were estimated to be 36,466 tonnes. The distribution of total VOCs within the main Market Segments is illustrated for both cases in **Figure 20**.

Excluding 'source controllable coatings', the main Market Segments are estimated to contribute to total VOCs in the following order: Architectural & Decorative (42%), Industrial (27%), Automotive Refinishing (17%) and Heavy Duty (14%).

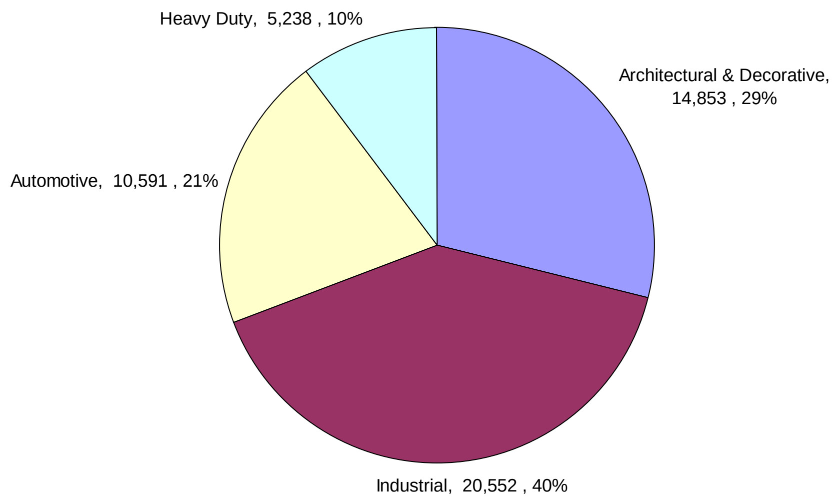
Based on the volume-weighted MIRs calculated for each Product Type, ozone formation potentials (expressed in tonnes/annum) were estimated and are depicted in **Figure 21**. Total ozone formation potential was estimated to be 106,270 tonnes O_3 per annum across all uncontrolled coatings. The ozone formation potential is therefore 2.9 times greater than the total VOC emission estimates. The overall surface coating sector could therefore be expressed as having a volume-weighted maximum incremental reactivity (MIR) of 2.9.

Due to the widespread use of water borne coatings, the contribution of the Architectural & Decorative Segment to ozone formation potential is lower (34%) than its contribution to total VOCs (42%). The contributions of the other market segments, where a high proportion of solvent borne coatings is in use, are as follows: Industrial (32%), Automotive Refinishing (19%) and Heavy Duty (15%).

Total VOCs and Ozone Formation Potentials calculated for each Product Category are summarized in **Table 21**. Product Category contributions to the total VOCs and ozone formation potentials estimated for each Market Segment are illustrated in **Figure 22** and **Figure 23** respectively. *No substantial difference in terms of the relative contributions of Product Categories to the VOC emission and ozone formation potentials of Market Segments are apparent.* This is also evident in **Figure 24** which illustrates the percentage contribution of each Product Category to VOC emission and ozone formation potentials of all coatings combined.

Figure 24 does however indicated that, by taking VOC reactivities into account, some change in the relative significance of Product Categories result. The significance of Architectural & Decorative Paints is, for example, reduced whereas the significance of Industrial Finishing Coats is enhanced.

**Total VOCs within All Surface Coatings Sold in Australia
(2007, tonnes)**



**VOC Content (Emissions) of All Surface Coatings Sold in Australia,
Excluding Industrial Coatings Applied in Controlled/Controllable Environments
(2007, tonnes)**

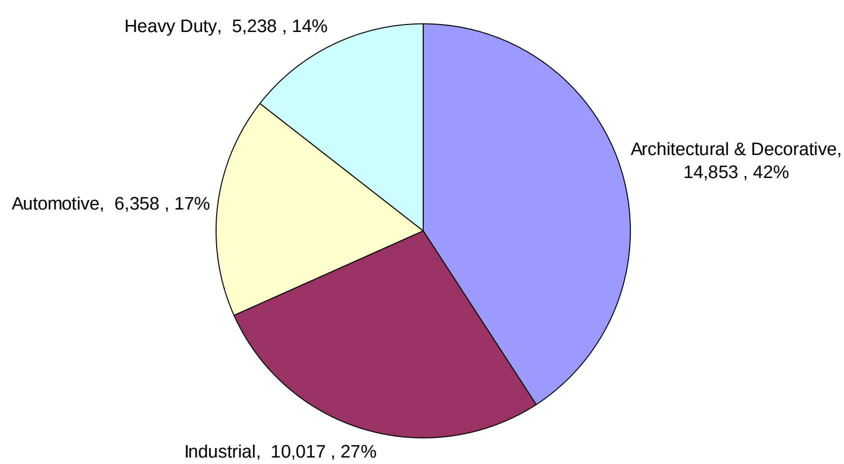


Figure 20: Total VOC contents of all surface coatings sold in Australia during 2007 by Market Segment, including and excluding 'source controllable coatings'

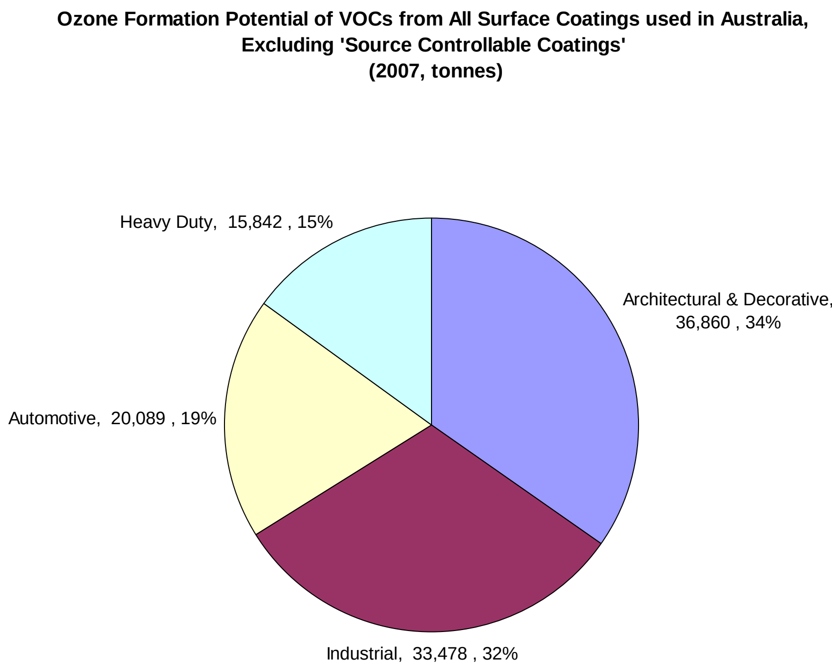


Figure 21: Ozone Formation Potential (tonnes) due to VOCs within surface coatings sold in Australia (2007) by Market Segment, excluding 'source controllable coatings'

Table 21: Volumes, total VOCs and associated Ozone Formation Potential of Surface Coatings Sold in Australia (2007), excluding 'source controllable coating' use.

Market Segment:	Product Category:	Volumes (litres)	Total VOCs (tonnes)- including acetone	Ozone Formation Potential (tonnes)	Solvent Content (g VOC/litre)(a)	Ozone Formation Potential (g O_3/litre)(a)	MIR(a)
Architectural & Decorative	Architectural & Decorative Paints & Enamels	141,495,498	9,234	23,491	65	166	2.54
	Architectural & Decorative Wood care	6,292,002	2,920	7,972	464	1,267	2.73
	Architectural & Decorative Thinners	2,698,718	2,699	5,397	1,000	2,000	2.00
Industrial	Road & Runway Marking	4,889,328	406	1,213	83	248	2.98
	Other Industrial - Finishing Coats	6,021,399	2,876	12,681	478	2,106	4.41
	Other Industrial - Primers & Undercoats	9,873,575	2,264	6,595	229	668	2.91
	Industrial Wood care	4,064,923	2,430	8,091	598	1,990	3.33
	Industrial Thinners	2,040,476	2,040	4,897	1,000	2,400	2.40
Automotive	Automotive Refinishing	10,167,024	6,358	20,089	625	1,976	3.16
Heavy Duty	Marine	1,011,768	390	1,285	386	1,270	3.29
	Yacht	652,785	236	780	361	1,195	3.31
	Protective Coatings	9,916,383	2,962	9,801	299	988	3.31
	PC Thinners	1,650,404	1,651	3,976	1,000	2,409	2.41
TOTAL		**200,774,282**	**36,466**	**106,270**			

(a) Represents the volume-weighted average overall product types within the category.

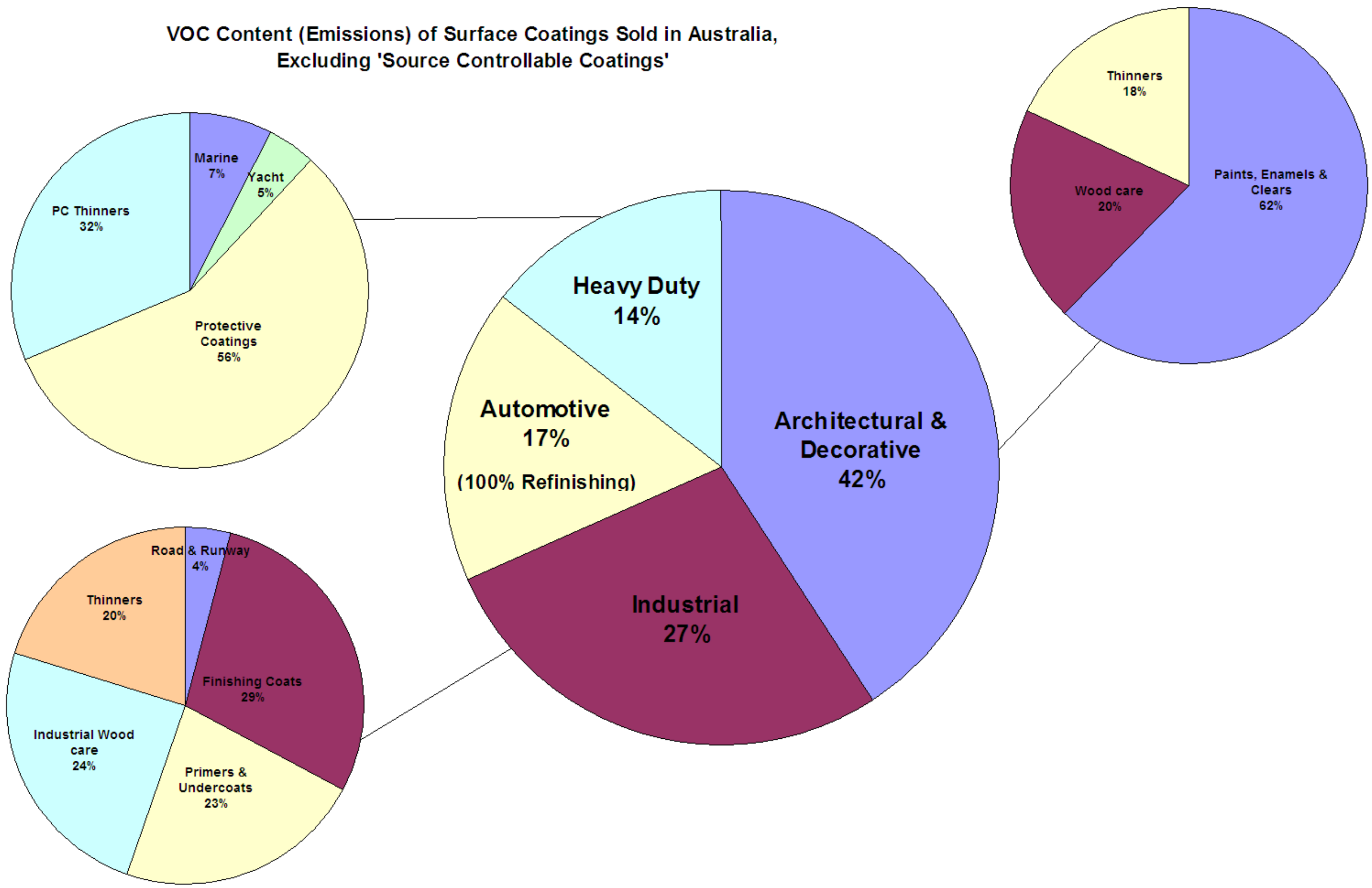


Figure 22: Total VOCs from surface coatings sold in Australia, excluding 'source controllable coatings' (2007).

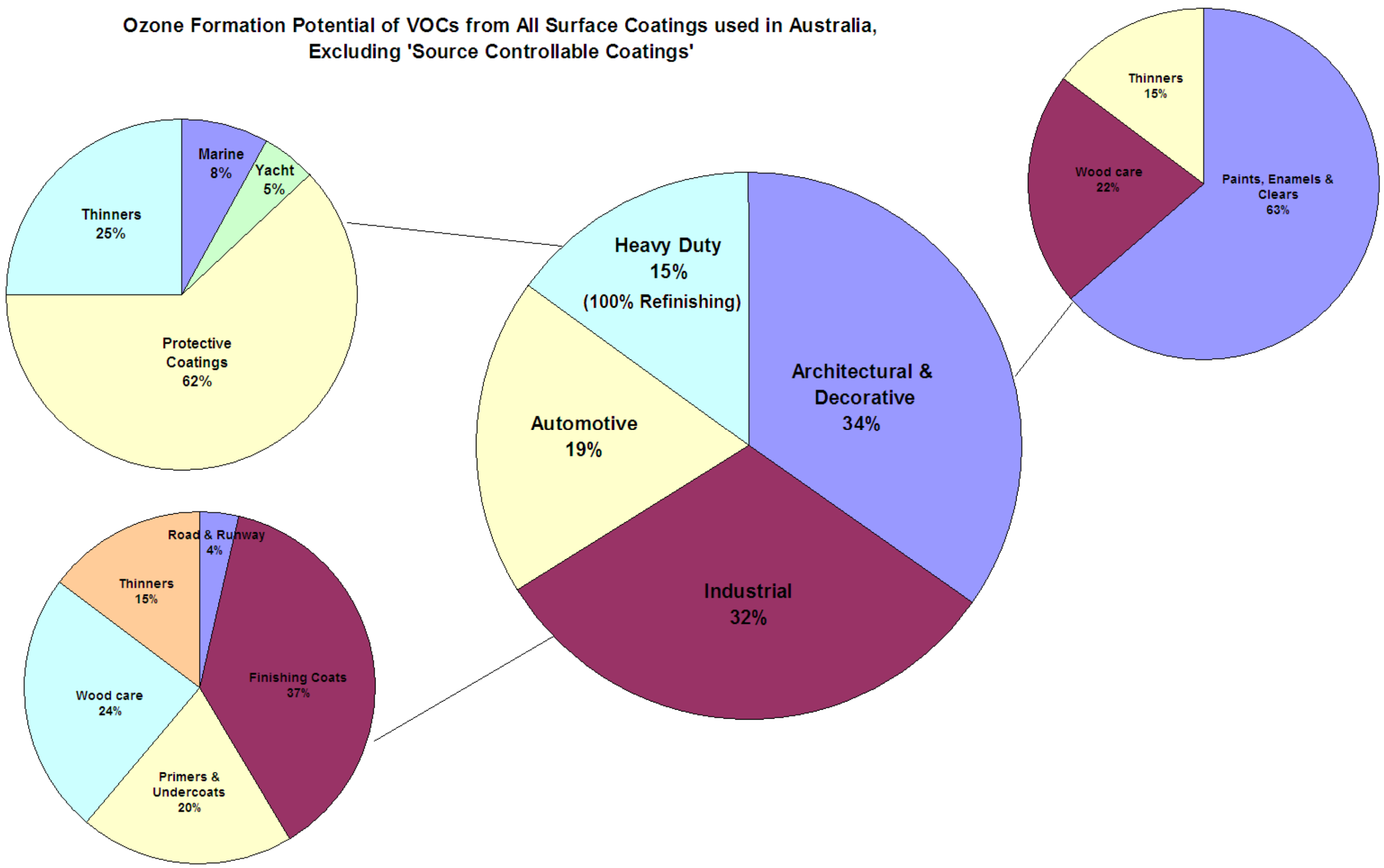


Figure 23: Ozone formation potential of VOCs from surface coatings sold in Australia, excluding 'source controllable coatings' (2007).

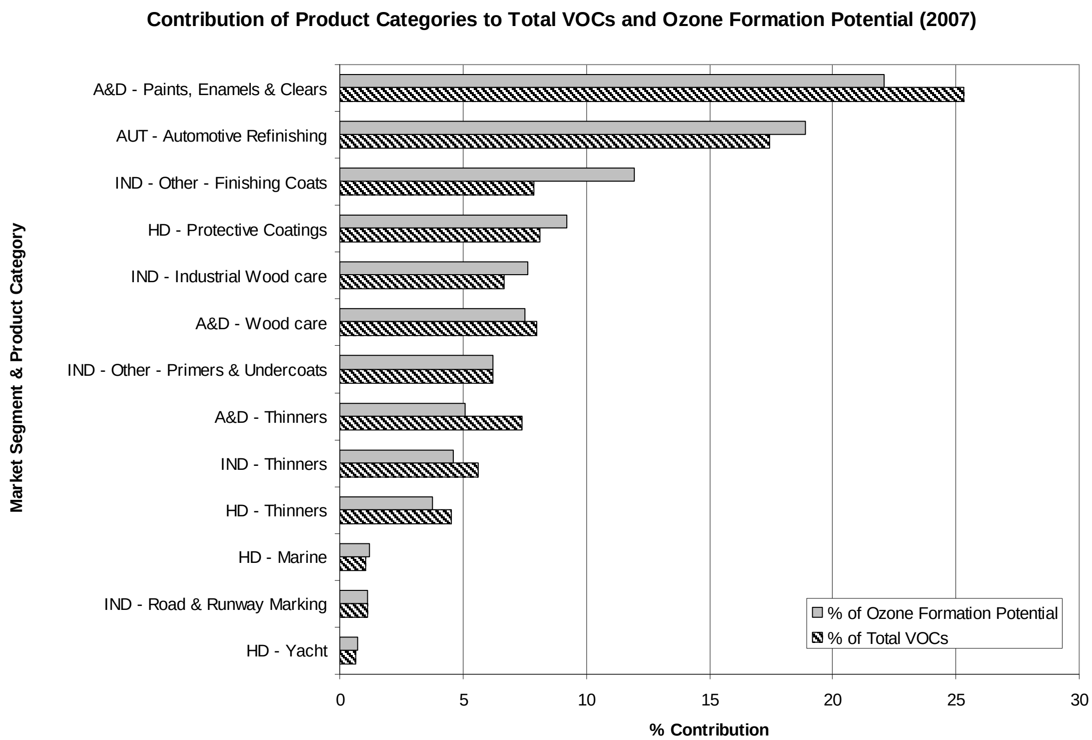


Figure 24: Contribution of Product Categories to total VOC emission and ozone formation potentials estimated for the Surface Coating Market (2007)

The most significant Product Categories in terms of total VOC and ozone formation potential were Architectural & Decorative Paints and Automotive Refinishing.

Industrial Finishing Coats, Protective Coatings, Industrial and Decorative Wood Care and Industrial Primers & Undercoats each contributed between 6% and 12% to ozone formation potentials.

Marine, Road & Runway Marking and Yacht/Pleasure Craft were noted to have minor contributions.

Detailed VOC and ozone formation potential estimates for individual Product Types are presented in **Appendix 7**. Contributions of individual Product Types are discussed in subsequent subsections for each of the Market Segments.

5.2.1 Architectural and Decorative Coatings

Ranges in the VOC contents and MIR values calculated for Architectural & Decorative Coating Product Types are given in **Appendix 7**. Volume-weighted VOC contents for water-borne coatings were estimated to range between 5 g/l and 90 g/l, with an MIR value of 2.49. Volume-weighted VOC contents for solvent-borne products were in the range of 390 g/l to 500 g/l with an MIR value of 2.6.

Solvent-borne Architectural & Decorative wood care products were estimated to have volume-weighted VOC contents in the range of 425 g/l to 635 g/l, and an MIR value of 2.73. Water-borne wood care products had a VOC content in the range 40 g/l to 140 g/l.

The relative contribution of such product types to VOCs and Ozone Formation Potential estimated for the Decorative Paints, Enamels & Clears Product Category is illustrated in **Figure 25**.

Solvent-based Door, Window, Trim coatings are noted to be the single largest contributor within this category (23%), despite accounting for less than 4% of the total volumes sold in this category.

Comparable contributions by water-based interior topcoats, solvent-based prepcoats, texture coatings and water-based exterior topcoats (11% to 13% each).

Despite being more limited in terms of volumes sold, paving paint (solvent-borne) and metal finishes account for 5% and 8% of the total VOCs respectively due to their being solvent-borne. Due to the relatively small volumes being sold, the contributions of solvent-based roof paint was estimated to be limited.

In the case of Architectural & Decorative Wood Care, solvent-borne decking paint was estimated to contribute most significantly to VOC contents and ozone formation potential (**Figure 26**). This is due to it being solvent-borne and due to decking paints comprising 45% of the volumes of Architectural & Decorative wood care products sold.

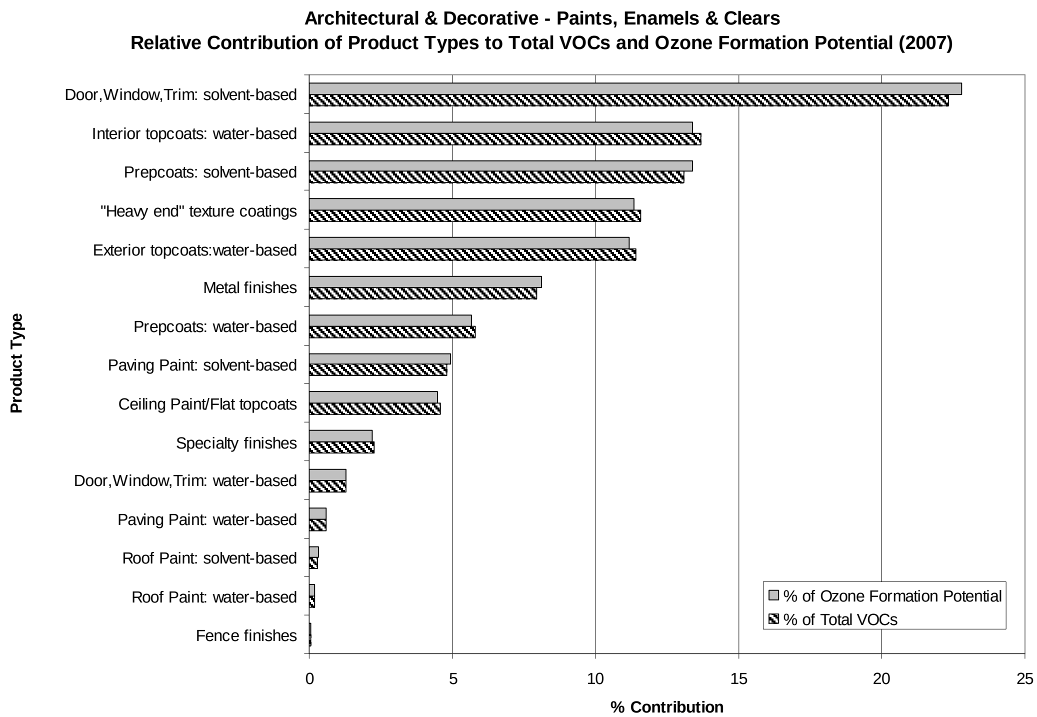


Figure 25: Relative contribution of Architectural & Decorative Paint Product Types to total VOCs and Ozone Formation Potentials for this Product Category

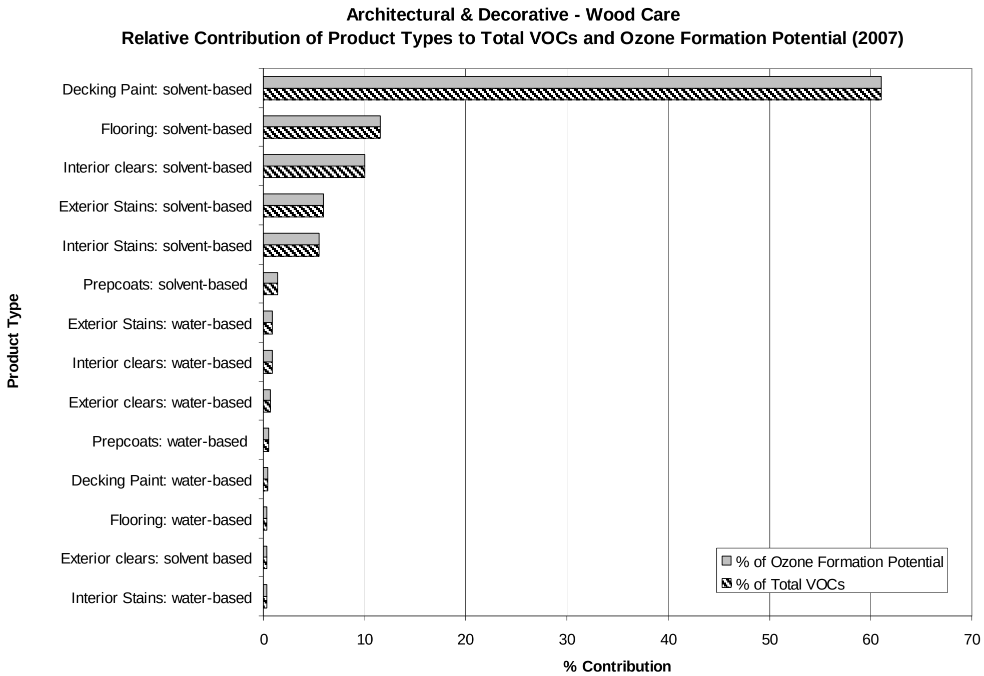


Figure 26: Relative contribution of Architectural & Decorative Wood Care Product Types to total VOCs and Ozone Formation Potentials for this Product Category

The local Architectural & Decorative coatings market has to date been dominated by locally produced paints. Whereas the use of 2007 data in the study is adequate to characterise the bulk of the current market, it is noted that paint imports are likely to increase significantly in coming years due in part to Bunnings decision to market Nippon paints from Japan. This brand was only launched by Bunnings in mid 2008, with the intention being to scale up sales with marketing.

To assess the implications of Nippon Paints, Bunnings was approached to provide VOC content information for the product types to be imported. The maximum VOC contents specified for Nippon Paints, as received from Carl Callaghan (National Paint Buyer, Bunnings Group Limited), are compared to the weighted-average VOCs calculated for products currently on the market.

Table 22: Comparison between maximum VOC contents specified for Nippon Paints and volume-weighted VOC contents calculated across products currently on the market

Architectural & Decorative – Paints, Enamels & Clears	Volume-weighted VOC Content from Coatings Covered by this Study	Maximum VOC Content of Nippon Paints (g/litre)(a)
Paving Paint: solvent-based		N.A
Paving Paint: water-based		N.A
Roof Paint: solvent-based		N.A
Roof Paint: water-based		N.A
Fence finishes		N.A
Specialty finishes		N.A
"Heavy end" texture coatings		N.A
Metal finishes		N.A
Spray packs		N.A
Prepcoats: water-based	44	Max 50(b)
Prepcoats: solvent-based		N.A
Ceiling Paint/Flat topcoats	24	Max 16(b)
Door,Window,Trim: water-based	71	Max 50(b)
Door,Window,Trim: solvent-based	393	Max 450(c)
Interior topcoats: water-based	31	Max 16(b)
Exterior topcoats: solvent-based		N.A

a) All figures are for untinted paint bases
b) Method ISO 17895 used.
c) Method ASTM D3960-04 used.

The maximum VOC contents specified by Bunnings was lower than the volume-weighted VOC contents estimated for locally sold coatings, except in the case of solvent-borne Door, Window, Trim coatings. The maximum VOC content specified for solvent-borne Door, Window, Trim coatings (450 g/l) is above the volume-weighted average of 393 g/l and the range (across companies) of 382 g/l to 411 g/l. Given the significance of this Product Type, in terms of its relative contribution to ozone formation potential, this is worthy of note.

5.2.2 Aerosol Coatings

Aerosol Coatings were not included in the Architectural & Decorative Coating Product Types but are addressed separately. According to the Informark (2007) sales data, a total of 1.53 million spray packs were sold. The units of spray packs reported to be locally sold was reported by five industry operators during Survey 1 to be 3.74 million. Only three of these industries provided VOC data (total of 450.7 tonnes). If the VOC volumes are scale up to account for the missing data, the total VOC volume is estimated to be ~520 tonnes (5% to 6% of the total VOCs from the Architectural & Decorative Paints Category).

If the data are accurate, that would indicate Aerosol Coatings to be as significant a contributor to VOC within this Product Category as, for example, water-borne prepcoats and metal finishes.

5.2.3 Automotive Refinishing

Ranges in the VOC contents and MIR values calculated for the estimated *end use* Automotive Refinishing Coating Product Types (including apportioned thinners and hardeners, as per **Table 18**) are given in **Appendix 7**.

Volume-weighted VOC contents for refinishing product types ranged from 13 g/L to 40 g/L for low VOC product types and from 547 g/L to 771 g/L for solvent-borne types. Volume-weighted MIRs were in the range of 1.9 to 4.9 across all product types, with an average of 3.2.

The relative contribution of individual product types to VOCs and Ozone Formation Potential estimated for the Automotive Refinishing Product Category is illustrated in **Figure 27**.

2K-Basecoats and 2K-Topcoats combined account for about 50% of the total VOCs and Ozone Formation Potential from the Automotive Refinish Product Category. The majority of the remaining Product Types had similar contributions (3% to 9% each).

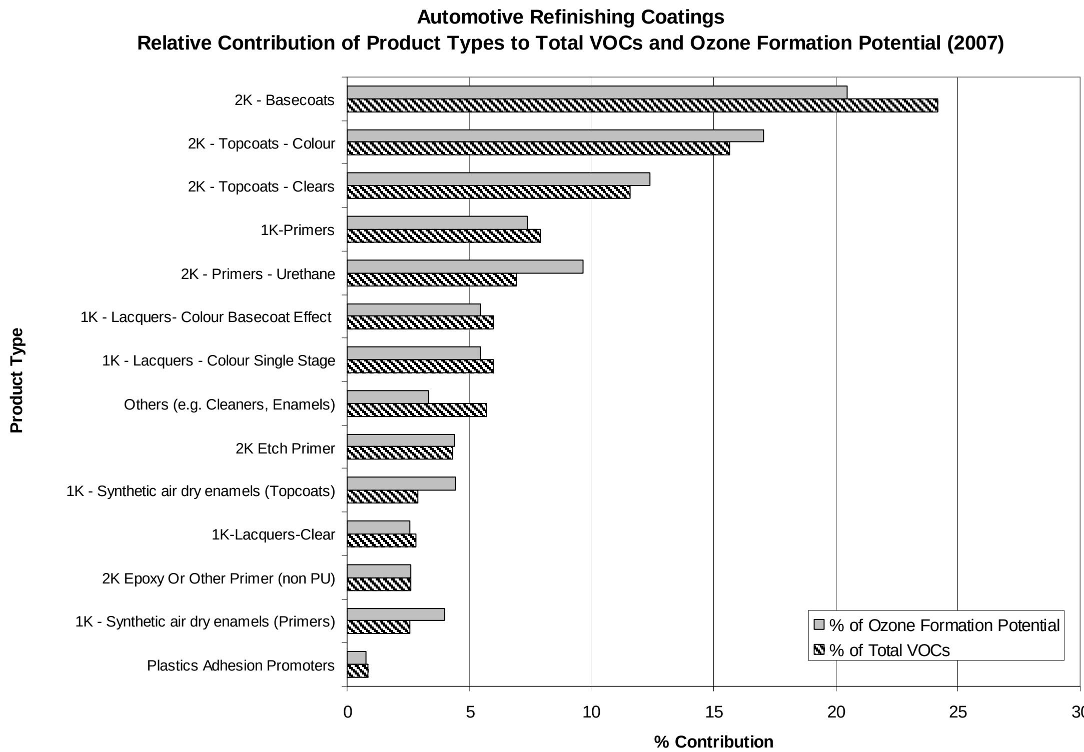


Figure 27: Relative contribution of Automotive Refinishing Product Types to total VOCs and Ozone Formation Potentials for this Product Category for this Product Category

5.2.4 Industrial Coatings

Ranges in the VOC contents and MIR values calculated for Industrial Coating Product Types are given in **Appendix 7**. The relative contribution of individual product types to VOCs and Ozone Formation Potential estimated for the Automotive Refinishing Product Category is illustrated in **Figure 28**.

Solvent-borne Baking Enamel Finishing Coats were estimated to account for 32% of the Ozone Formation Potential of the Industrial Coatings Segment. This was due to its high VOC content (weighted-average of 753 g/l), high MIR (5.15) and due to it comprising a significant portion of the industrial sales volumes (10%).

Industrial Wood Care Solids and Clears together accounted for 24% of the Ozone Formation Potential. These coatings represented 14% of the sales volumes, and have VOC contents of 510 g/l to 610 g/l.

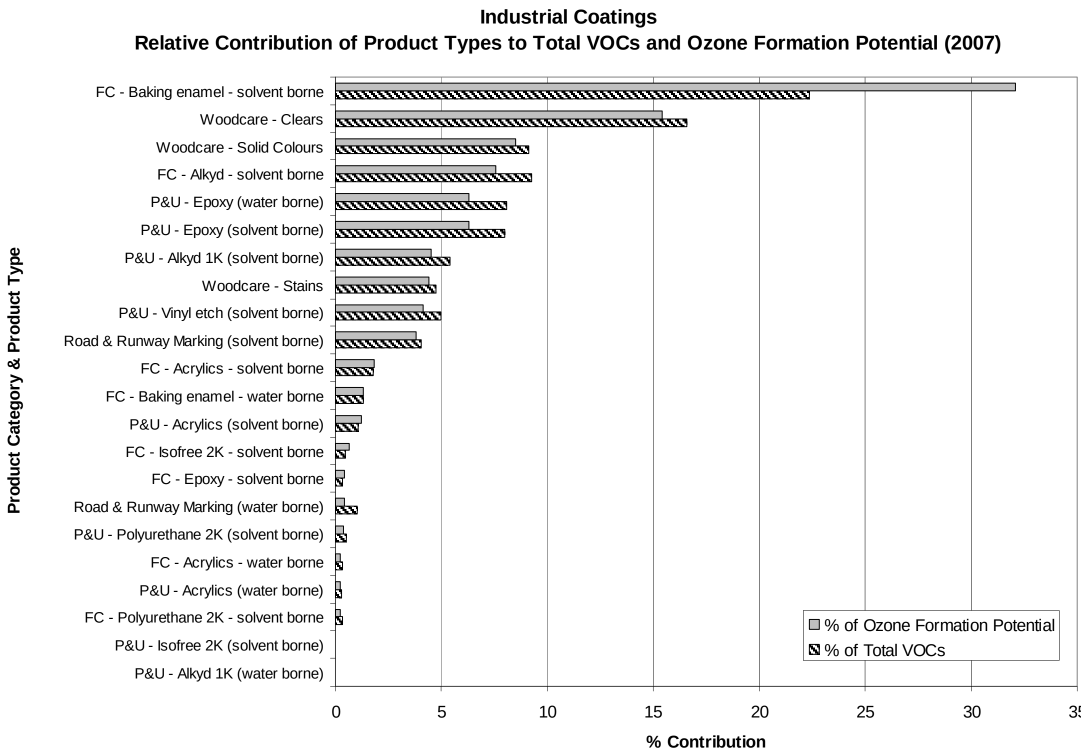


Figure 28: Relative contribution of Industrial Product Types to total VOCs and Ozone Formation Potentials for this Product Category

5.2.5 Marine and Protective Coatings

Ranges in the VOC contents and MIR values calculated for Heavy Duty Coating Product Types are given in **Appendix 7**.

The relative contribution of individual product types to VOCs and Ozone Formation Potential estimated for the Protective Coating, Marine and Yacht/Pleasure Craft Categories are illustrated in **Figure 30**, **Figure 31** and **Figure 32** respectively.

Multi-component Topcoats and 2K Epoxy coatings together accounted for 47% of the Ozone Formation Potential estimated for the Protective Coatings Category. 1K Steel Protection, Zinc Rich, 1K Topcoat and Primer/Surfacer coatings each contributed about 10% to 15%.

Antifouling coatings were estimated to be the most significant contributor to Ozone Formation Potentials within both the Marine and Yacht Coating Categories, accounting for ~40% in both cases. This contribution primarily reflects the volumes of these coatings as a proportion of sales (32% for Yacht and 36% for Marine).

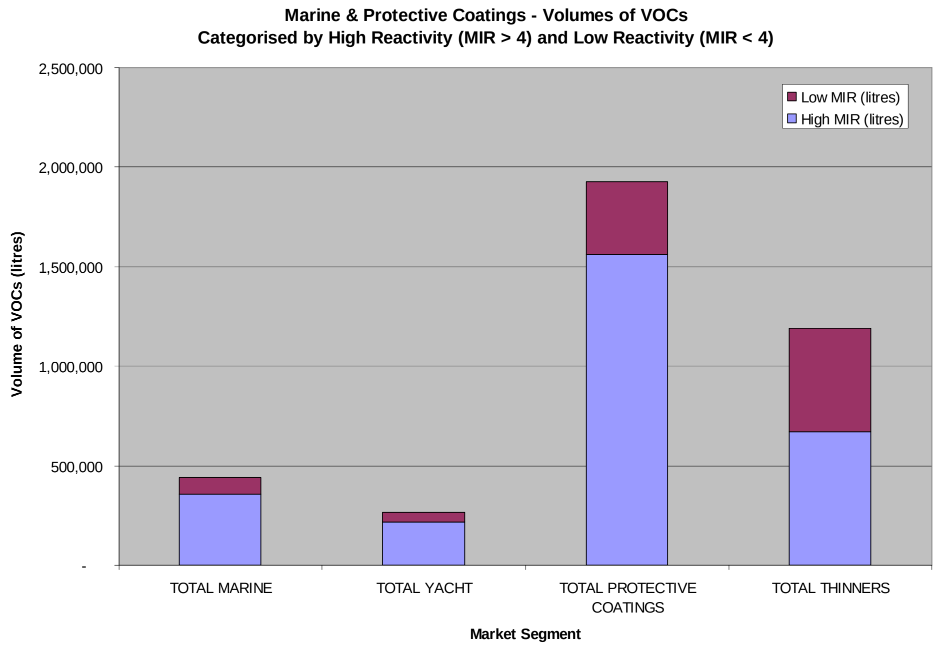


Figure 29: Volumes of VOCs in Heavy Duty Coatings classified by 'high' and 'low' reactivity

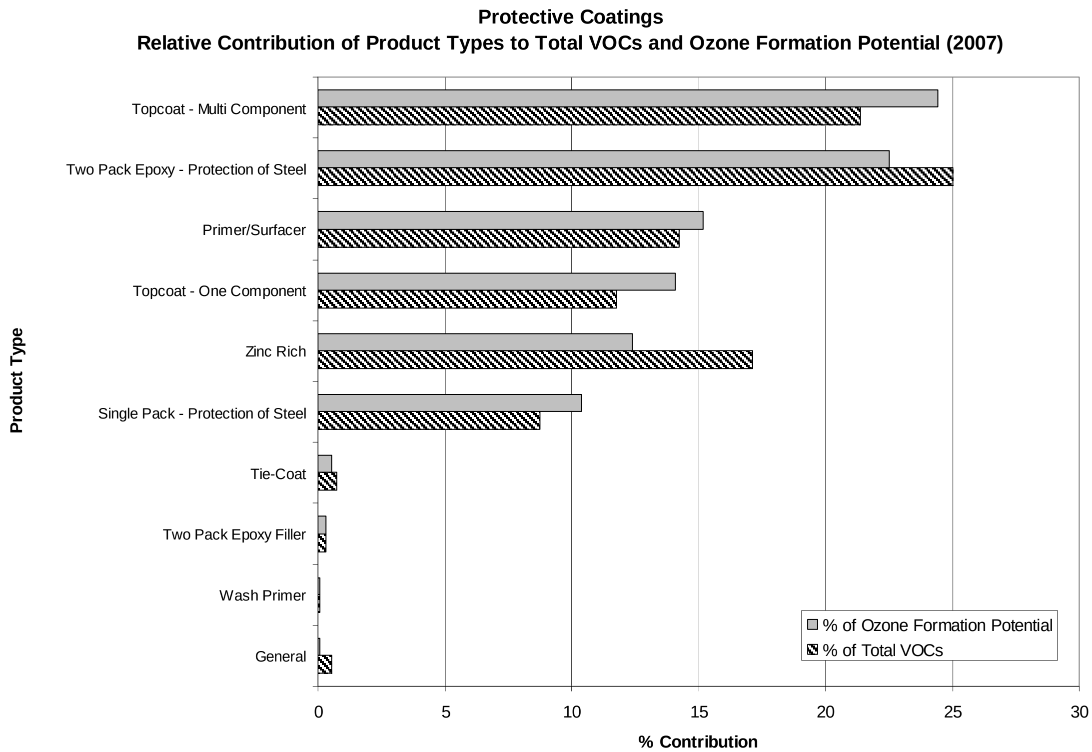


Figure 30: Relative contribution of Protective Coating Product Types to total VOCs and Ozone Formation Potentials for this Product Category

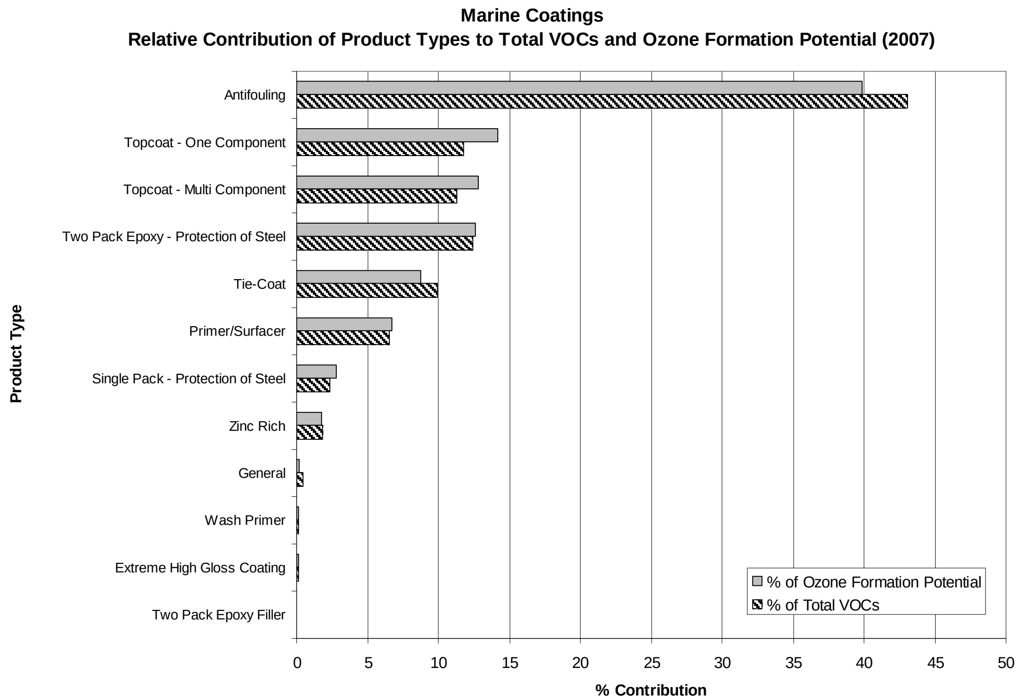


Figure 31: Relative contribution of Marine Coating Product Types to total VOCs and Ozone Formation Potentials for this Product Category

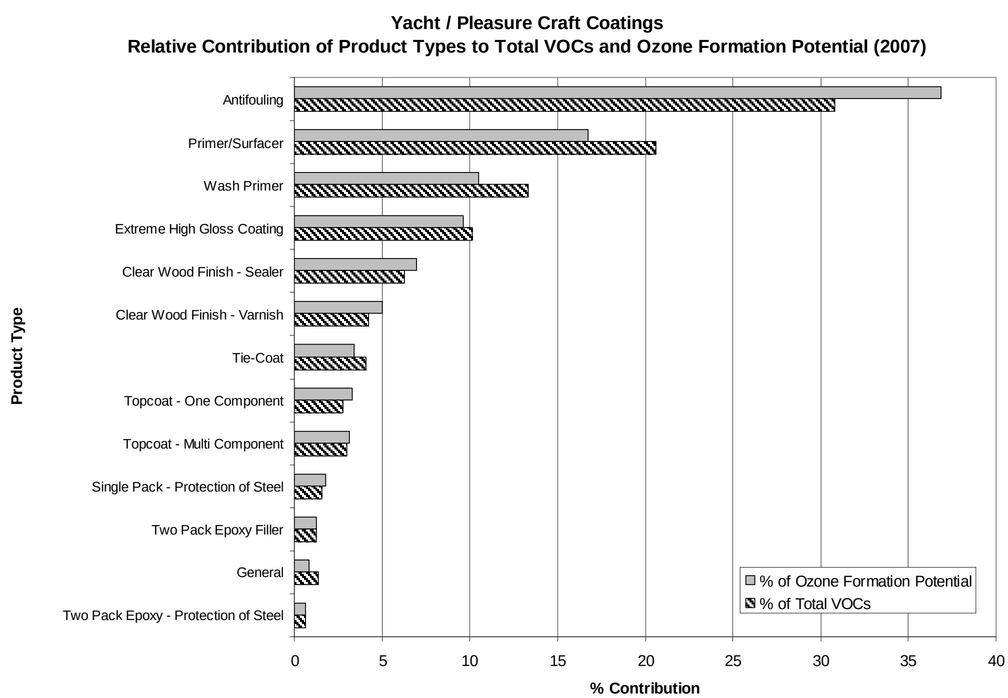


Figure 32: Relative contribution of Protective Coating Product Types to total VOCs and Ozone Formation Potentials for this Product Category

5.2.6 Use of Thinners

A summary of the thinners estimated to be used within each of the Market Segments is given in **Table 23**. Whilst being estimated to comprise ~5% of total coatings sales, thinners are estimated to account for 24% of the total VOCs (21% of the ozone formation potential) across all the Coating Products Inventoried. The Automotive Refinishing sector represents the largest user of thinners, followed by the Architectural & Decorative sector.

Table 23: Estimated use of thinners by Market Segment

Product Category:	Volumes (litres)	Total VOCs (tonnes)	Ozone Formation Potential (tonnes)
Architectural & Decorative Thinners	2,699	2,699	5,397
Industrial Thinners	2,040	2,040	4,897
Automotive Refinishing Thinners	3,317	2,650	8,232
Heavy Duty Thinners	1,650	1,651	3,976
TOTAL	**9,706**	**9,040**	**22,503**

5.2.7 Contribution of VOCs from Surface Coatings to Total Anthropogenic VOCs

According to the National Pollutant Inventory (NPI), total anthropogenic VOC emissions are estimated to be 800,000 tonnes for the 2006-7 reporting year.

The potential contribution of surface coating VOCs estimated in this study to total anthropogenic VOC emissions is as follows:

- Architectural and Decorative (1.9%, conservatively 2.3%)
- Industrial Coatings (1.3%)
- Automotive Refinishing (0.8%)
- Heavy Duty (0.7%)

The combined contribution was estimated to be 4.7%.

VOC contents estimated during the current study, and hence assumed VOC emissions, were lower than has been estimated in the National Pollutant Inventory (NPI). This is primarily due to differences in coating volume estimates and emission methodologies applied.

6 Comparisons with Local and International VOC Limits

To meet the objectives of the study the portion of coating products likely to meet local (APAS) and international best practice VOC limits is evaluated, and the potential emission reductions (in tonnes of VOCs) achievable if all coating products comply with such limits considered.

6.1 Overview of Local and International VOC Limits

In preparation for this assessment an inventory was undertaken of applicable regulations/specifications containing VOC limits for coating products. The following were noted to be of relevance:

- Australian Paint Approval Scheme (APAS), Document D181, Volatile Organic Compounds (VOC) Limits, 8 December 2006 – specified for 15 high volume architectural product types, 18 other architectural products, and 17 industrial and protective coating products.
- Good Environmental Choice Australia Ltd Australian Ecolable program, Architectural and Protective Coatings, Standard GECA 23-2005, March 2006 – comprising 13 product types and VOC levels for architectural coating products.
- European Directive 2004/42/CE on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC, 21 April 2004. General categories specified for 12 types of architectural and decorative coatings and 7 types of automotive refinishing products.
- Canadian Department of Environment, *Proposed* Volatile organic compound (VOC) concentration limits for architectural coatings regulations, 26 April 2008. Provision is made for 49 product types within the architectural coatings segment.
- Hong Kong Environmental Protection Department (EPD), Air Pollution Control (Volatile Organic Compounds) Regulation, 2007 – comprises 50 architectural and industrial product types.
- Hong Kong Environmental Protection Department, *Proposal* for Control of Volatile Organic Compound Emissions from Vehicle Refinishing Paints, Marine Vessel Paints and Pleasure Craft, May 2008 – covers 12 vehicle refinishing paint types, 18 marine vessel types and 11 pleasure craft coating types.
- California Air Resources Board (CARB), Suggested Control Measures (SCM), set 2000 and amended 2007, given for 43 architectural coating categories.
- United States Environmental Protection Agency (EPA), architectural coatings rule 63 FR 176:48848, adopted 1998 and last amended 1999, given for 63 architectural product types.
- US-EPA, Source Federal Register, Updated 7/24/03, Subpart B – National volatile organic compound emission standards for automobile refinishing coatings. VOC limits specified for 7 general automotive refinishing categories.

- United States EPA National Volatile Organic Compound Emission Standards for Aerosol Coatings (aerosol spray paints), 2007.
- CARB Regulation for Reducing the Ozone formed from Aerosol Coating Product Emissions, 2007.

Due to the manner in which VOCs were defined and VOC content established during the study (as documented in **Section 5.1.1**), it was apparent that the VOC contents calculated for Product Types within the study were most suited for comparisons with APAS and EU VOC limits.

Comparisons with US, CARB, Hong Kong and Canadian limits were problematic in that such limits are specified for coatings excluding the volume of water added and any exempt compounds added. Efforts were however made in evaluating the Automotive Refinishing segment, to apply CARB limits and compare VOC and ozone forming potential reductions achievable compared to reductions implied by EU limits for this segment.

6.1.1 APAS VOC Limits

The Australian Paint Approval Scheme (APAS) has certified the performance of paint for government procurement since 1943. APAS specifications are issued for specific product types or end uses and cover the range of paint properties such as density, viscosity and durability. APAS currently has over 200 specifications, and over 2000 approved products. (Approximately 4000 products are currently registered in the APMF's Paint Trade Manual.)

Limits on the VOC content of paints was first issued by APAS in 1995, being specified for architectural and industrial coatings in two-yearly cycles. Given however that the average life of a paint formula is typically in the order of 5 years, it was decided to revisit limits over 5-yearly intervals. Since 2003 APAS has consulted with the APMF and end users, notably government, in regard to the revision of its VOC limits. The outcome of deliberations was reduction of the VOC limits for architectural coatings from a range of 60 to 100 g/litre to 50 to 80 g/litre.

Although APAS specifications are primarily used for government procurement, such specifications influence the wider consumer market and serve as performance benchmarks. APAS estimates that approximately 80% (by volume) of all Architectural & Decorative coatings sold in Australia are APAS approved. All major paint manufacturers and the majority of medium-sized manufacturers have chosen to participate in APAS to some extent, with APAS having the potential of covering the bulk of products sold on the market if extended.

The initial environmental benefits of low VOC coatings may be offset if the durability of the coating is affected as a result of reformulations to reduce the solvent content, requiring it to be applied more frequently. An important aspect of the APAS scheme is that it combined VOC limits with specifications for durability and usability. Coatings need to maintain a minimum standard of performance and have lower VOC limits to meet APAS specifications.

APAS 181 specifies revised VOC limits which became effective in January 2007. Two criteria are specified: (i) a maximum for each product and (ii) a total average VOC emission limit over the entire product range. The average is applicable to weighted-averages calculated over a manufacturer's product range (e.g. low sheen interior wall finishes), with the maximum being applied to each product in the range.

The APAS limits are stipulated for high volume products and for other APAS approved products including lower volume Architectural & Decorative products and certain industrial and protective coating products. A new category covering ultra low VOC architectural paints (<5 g/litres) is also included in the APAS limits. APAS VOC limits are given in **Appendix 8**. The VOC definition and methods used for calculating VOC content for assessing compliance with such limits were covered in **Section 5.1.1**.

Given the change in APAS VOC limits over the past decade, it is estimated that VOC load has decreased by 22% despite architectural paint production having increased by 32% during that period (NSW DECC, 2007).

6.1.2 EU VOC Limits

The EU Directive 2004/42/EC limits the total content of VOCs in paints for use on buildings, their trimmings and fittings and structures associated to buildings and products for vehicle refinishing. The legislation is incremental, setting initial limits which were applied from January 2007, with a more stringent set of limits coming into force in January 2010. Only one set of limits are issued for vehicle refinishing (came into force January 2007).

The EU VOC limits are more stringent than those in the US. It is intended that such regulations reduce VOC emissions from decorative paints by approximately 50% (280,000 tonnes per year). This requires that the VOC content of specific paint ranges be reduced by 20% to 50% over the Phase 1 to Phase 2 cycles.

EU VOC limits are given in **Appendix 9**. The VOC definition and methods used for calculating VOC content for assessing compliance with such limits were covered in **Section 5.1.1**.

6.1.3 California Air Resource Board (CARB) VOC Limits

US VOC limits are specified for 7 general automotive refinishing categories. CARB has VOC regulatory limits for 10 automotive refinishing categories effective 1 January 2009, and regulatory limits for a further 3 categories which come into effect on 1 January 2010. The US and Californian VOC limits are given in **Appendix 10**. The VOC definition and methods used for calculating VOC content for assessing compliance with such limits were covered in **Section 5.1.1**. For the purpose of the current assessment reference was made to the CARB regulatory limits.

As for the federal limits, CARB defines VOCs as any organic compound that participates in atmospheric photochemical reactions, that is, any organic compound other than those which are specifically designated as having negligible photochemical reactivity and declared as being exempt. As a result of the VOC definition applied in the US, automotive refinish products are frequently formulated to include exempt solvents in order to meet the regulatory limits, thus complying with the limit despite potentially having a higher total VOC content compared to automotive products formulated to meet EU limits.

In assessing the VOC reduction potential achievable through the implementation of CARB limits it is therefore necessary to consider the manner in which different product types may be reformulated under the US VOC definition.

6.1.4 Locally Proposed Heavy Duty VOC Limits

VOC limits for Marine and Yacht coatings are published by CARB and proposed for promulgation in Hong Kong. Given that these limits are applicable to ready for use products which exclude water it is not possible to compare the VOC contents of surface coatings derived in the study with such limits.

A set of maximum VOC limits applicable to Protective Coating, Marine and Yacht coatings was however proposed by a representative of Akzo Nobel (International) during the consultation process. These limits are based on VOC contents which, it is perceived, could readily be achieved given existing technology (**Table 24**).

Table 24: Proposed Maximum VOC Limits for Marine and Yacht Coatings, introduced for discussion during study consultations (*personal communication*, Shaun Mizis, Akzo Nobel Pty Lt, International Paint, September 2008)

Division	Category	Proposed Maximum VOC Limit (g/lt on mixed product)
Marine	Antifouling	600
Marine	Foul Release	450
Marine	General	680
Marine	Primer/Surfacer	530
Marine	Single Pack - Protection of Steel	560
Marine	Tie-Coat	460
Marine	Topcoat - Multi Component	650
Marine	Topcoat - One Component	460
Marine	Two Pack Epoxy - Protection of Steel	520
Marine	Two Pack Epoxy Filler	350
Marine	Wash Primer	780
Marine	Zinc Rich	650
Marine	Extreme High Gloss Coating	650
Yacht	Antifouling	600
Yacht	Clear Wood Finish - Sealer	800
Yacht	Clear Wood Finish - Varnish	650
Yacht	Foul Release	450
Yacht	General	700
Yacht	Primer/Surfacer	700
Yacht	Single Pack - Protection of Steel	560
Yacht	Tie-Coat	460
Yacht	Topcoat - Multi Component	650
Yacht	Topcoat - One Component	480
Yacht	Two Pack Epoxy - Protection of Steel	580

Table 24: Proposed Maximum VOC Limits for Marine and Yacht Coatings, introduced for discussion during study consultations (*personal communication*, Shaun Mizis, Akzo Nobel Pty Lt, International Paint, September 2008)

Division	Category	Proposed Maximum VOC Limit (g/lt on mixed product)
Yacht	Two Pack Epoxy Filler	350
Yacht	Wash Primer	800
Yacht	Extreme High Gloss Coating	700
PC	Intumescent	400
PC	General	680
PC	Primer/Surfacer	680
PC	Single Pack - Protection of Steel	580
PC	Tie-Coat	580
PC	Topcoat - Multi Component	650
PC	Topcoat - One Component	580
PC	Two Pack Epoxy - Protection of Steel	580
PC	Two Pack Epoxy Filler	350
PC	Wash Primer	780
PC	Zinc Rich	650

6.2 Comparison with APAS VOC Limits

6.2.1 Evaluation of Compliance based on Data received from APAS

Information on the VOC contents of products listed on the APAS data base was also received from APAS Executive Officer Mr Ken Lofhelm. VOC contents were available for approximately 840 of the 2130 products on the APAS data base (39.6% of products). These VOC contents were assessed by Product Type to facilitate comparisons with APAS limits. A synopsis is given in **Table 25** of the range, median and average VOC contents noted by Project Type. The number of products within each Product Type with VOC contents in excess of maximum APAS limits was noted.

About 30 products were concluded to exceed the applicable maximum APAS limit (ie. 4% of products in the inventory).

Unfortunately, products are only identified by number with no further details (e.g. manufacturer, volumes produced/sold) being available. For this reason, compliance with the average VOC limits could not be established. The extent of non-compliance with maximum VOC limits, as a percentage of product volumes, could also not be determined.

6.2.2 Evaluation of Compliance based on Data Generated by the Study

The APAS limits are in certain cases set for very specific product types and care had to be taken to ensure that the limits selected were applicable to the Product Types for which VOC contents were established.

APAS limits identified as being appropriate for application in the study covered approximately 70% of all Architectural & Decorative Paints and 80% of all Protective Coatings (by volume), in addition to Road & Runway Marking Paint. Excluding thinners and 'source controllable coatings', the APAS limits were applicable to almost 60% of all coatings considered.

Results from the assessment of VOC contents estimated for Architectural & Decorative Coatings against maximum and average APAS limits are provided in **Table 26** and **Table 27** respectively. The evaluation of VOC contents for Industrial and Protective Coatings, based on APAS maximum limits, is documented in **Table 28**.

APAS VOC limit exceedances were projected to occur for:

Coating:	% of Companies Exceeding Limits:	% of Product (by Volume) Exceeding Limits:
Paving paint, water-borne	20%	40%
Roof paint, solvent-borne	20%	6%
Prepcoats, solvent-borne	20%	32%
Prepcoats, water-borne	20%	39%
Ceiling paint/flat topcoats	20%	4%
Interior topcoats, water-borne	20%	4%
Exterior topcoats, water-borne	60%	53%
Road & Runway Marking (solvent borne)	50%	22%
Protective Coating - Primer/Surfacer	60%	33%
Two Pack Epoxy - Protection of Steel	20%	1%

It is noted that the exceedances given above for protective coatings are likely to be an under prediction due to the assessment being based primarily on production rather than 'ready for use' data. Companies providing 'ready for use' coatings data were noted to exceed the limits by a greater margin.

Total VOC load reduction estimated to occur if all products were brought below APAS limits was of the order of:

- 249 tonnes for Architectural Decorative Paints (i.e. 3.4% of total VOCs for this Product Category).
- 13.7 tonnes for Road & Runway Marking (3.4% of the VOCs for this Product Type).
- 25 tonnes for the Protective Coatings (~2% of total VOCs for these Product Types).

Given the total VOC reduction (287 tonnes/annum), and the product-specific MIRs calculated, the total reduction in Ozone Formation Potential is expected to be of the order of 800 tonnes/annum.

Table 25: Evaluation of compliance with APAS Limits by Products Inventoried by APAS

APAS Speciation number & Description		APAS Limits		Number of products	VOC Concentration (g/L)				VOC Concentration / Maximum Limit				No. Products > Max	% of products > Max
		Ave (g/l)	Max (g/l)		Max	Ave	Median	Min	Max	Ave	Median	Min		
High Volume Architectural Products														
0134	Latex primer for galvanised iron & Zincalume	45	50	4	57	44	45	28	1.14	0.88	0.90	0.57	2	50
0172	Interior sealer	50	60	38	87	36	39	0	1.45	0.59	0.65	0.00	6	16
0183	Exterior timber primer	50	60	11	54	40	45	12	0.90	0.67	0.75	0.20		
0260/1	Interior gloss	75	90	19	88	55	46	38	0.98	0.61	0.51	0.42		
0260/2	Interior semi gloss	65	80	46	78	45	48	0	0.98	0.56	0.60	0.00		
0260/3	Interior low sheen	50	75	104	75	36	35	0	1.00	0.48	0.47	0.00		
0260/4	Interior flat - washable	60	70	38	69	39	42	0	0.99	0.56	0.59	0.00		
0260/5	Interior flat - ceilings	50	60	38	76	35	36	0	1.26	0.58	0.60	0.00	4	11
0280/1	Exterior gloss	60	85	72	91	45	49	0	1.07	0.53	0.58	0.00	3	4
0280/2	Exterior semi gloss	60	80	36	64	36	34	6	0.80	0.45	0.42	0.08		
0280/3	Exterior flat & low sheen	45	70	75	68	34	34	1	0.97	0.48	0.49	0.01		
0280/4	Exterior gloss	65	80	33	80	51	52	0	1.00	0.64	0.65	0.00		
0280/5	Exterior low sheen	50	80	57	83	34	32	5	1.04	0.43	0.40	0.06	1	2
Other Architectural Products														
0011	Solvent borne roof paint for galvanised steel		450	4	432	408	401	398	0.96	0.91	0.89	0.88		
0012	Latex roof paint		100	2	79	71	71	63	0.79	0.71	0.71	0.63		
0015	Exterior/interior alkyd, gloss & semi gloss		450	109	444	394	404	0	0.99	0.88	0.90	0.00		
0024	Exterior oil & petrol resistant enamel		450	11	426	385	385	348	0.95	0.86	0.86	0.77		
0029	Undercoat (oil & petrol resistant)		450	1	398	398	398	398	0.88	0.88	0.88	0.88		
0032	Metal primer (buildings - excluding lead & chromates)		550	6	506	472	489	398	0.92	0.86	0.89	0.72		
0055	One pack exterior varnish (general purpose)		550	1	412	412	412	412	0.75	0.75	0.75	0.75		
0114	One pack interior varnish (general purpose)		500	10	496	403	474	93	0.99	0.81	0.95	0.19		
0162	Zinc phosphate metal primer		550	10	499	375	458	0	0.91	0.68	0.83	0.00		
0171	Interior solvent based sealer		450	2	414	405	405	395	0.92	0.90	0.90	0.88		
0181	Primer		450	11	394	361	363	317	0.88	0.80	0.81	0.70		
0200	One pack pigmented solvent borne paving paint		550	5	428	330	416	0	0.78	0.60	0.76	0.00		
0215	Low odour/low environmental impact		5	19	0.68	0.38	0.50	0.00	0.14	0.08	0.10	0.00		
Industrial & Protective Coating Products														
2930	Single pack moisture cure urethane for steel		400	3	323	317	314	314	0.81	0.79	0.78	0.78		
2971	Epoxy primers, 2 pack		400	9	432	284	342	0	1.08	0.71	0.85	0.00	1	11
2972	Low build epoxy GP enamel, 2 pack		350	10	344	298	324	12	0.98	0.85	0.93	0.03		
2973	Solvent borne epoxy to 400 µm, 2 pack		350	22	344	185	186	0	0.98	0.53	0.53	0.00		
2974	Solventless epoxy to 400 µm, 2 pack		120	5	380	195	116	0	3.17	1.62	0.97	0.00	2	40

Table 25: Evaluation of compliance with APAS Limits by Products Inventoried by APAS

APAS Speciation number & Description		APAS Limits Ave (g/l)	APAS Limits Max (g/l)	Number of products	VOC Concentration (g/L) Max	VOC Concentration (g/L) Ave	VOC Concentration (g/L) Median	VOC Concentration (g/L) Min	VOC Concentration / Maximum Limit Max	VOC Concentration / Maximum Limit Ave	VOC Concentration / Maximum Limit Median	VOC Concentration / Maximum Limit Min	No. Products > Max	% of products > Max
2976	Solvent borne epoxy mastic		180	3	157	157	157	157	0.87	0.87	0.87	0.87		
2977	Solvent borne epoxy mastic, slow drying; high volume solids; >400 µm		180	29	256	180	168	91	1.42	1.00	0.93	0.51	11	38

Table 26: Compliance with APAS maximum VOC limits for Architectural & Decorative Coatings

Architectural & Decorative Product Category	VOC Contents (g/l) across Companies Maximum	VOC Contents (g/l) across Companies Volume-weighted	VOC Contents (g/l) across Companies Minimum	APAS Max VOC Limit (g/l)	VOC Contents (g/l) as Ratio of APAS VOC Limit (>1 exceeds) Maximum	VOC Contents (g/l) as Ratio of APAS VOC Limit (>1 exceeds) Volume-weighted	VOC Contents (g/l) as Ratio of APAS VOC Limit (>1 exceeds) Minimum	% of Companies Complying with APAS Limit	% of Coatings (as volume) Complying with APAS Limit	VOC Reductions Achievable for 100% Compliance (tonnes/annum)
Paving Paint: solvent-based	524	498	429	550	0.95	0.91	0.78	100	100	-
Paving Paint: water-based	82	70	21	80	**1.02**	0.87	0.26	80	60	0.5
Roof Paint: solvent-based	465	407	388	450	**1.03**	0.9	0.86	80	94	0.1
Roof Paint: water-based	88	84	12	100	0.88	0.84	0.12	100	100	-
Prepcoats: water-based	56	44	23	65	0.87	0.67	0.36	100	100	-
Prepcoats: solvent-based	574	462	360	450	**1.28**	**1.03**	0.8	80	68	101.5
Ceiling Paint/Flat topcoats	60	24	5	60	1.00	0.4	0.08	80	96	-
Interior topcoats: water-based	58	31	17	70	0.83	0.44	0.24	100	100	-
Exterior topcoats: water-based	60	46	34	70	0.86	0.65	0.49	100	100	-
TOTAL										**102.1**

Table 27: Compliance with APAS average VOC limits for Architectural & Decorative Coatings

Architectural & Decorative Product Category	VOC Contents (g/l) across Companies			APAS Average VOC Limit (g/l)	VOC Contents (g/l) as Ratio of APAS VOC Limit (>1 exceeds)			% of Companies Complying with APAS Limit	% of Coatings (as volume) Complying with APAS Limit	VOC Reductions Achievable for 100% Compliance (tonnes/annum)
	Maximum	Volume-weighted	Minimum		Maximum	Volume-weighted	Minimum			
Prepcoats: water-based	56	44	23	55	**1.02**	0.80	0.42	80	61	6.2
Ceiling Paint/Flat topcoats	60	24	5	50	**1.20**	0.49	0.10	80	96	7.4
Interior topcoats: water-based	58	31	17	50	**1.16**	0.61	0.34	80	99.6	1.3
Exterior topcoats: water-based	60	46	34	45	**1.34**	**1.02**	0.76	40	47	131.7
TOTAL										**146.6**

Table 28: Compliance with APAS maximum VOC limits for Industrial & Protective Coatings

Architectural & Decorative Product Category	VOC Contents (g/l) across Companies			APAS Maximum VOC Limit (g/l)	VOC Contents (g/l) as Ratio of APAS VOC Limit (>1 exceeds)			% of Companies Complying with APAS Limit	% of Coatings (as volume) Complying with APAS Limit	VOC Reductions Achievable for 100% Compliance (tonnes/annum)
	Maximum	Volume-weighted	Minimum		Maximum	Volume-weighted	Minimum			
Road & Runway Marking (water borne)	22	21	20	60	0.37	0.34	0.33	100	100	
Road & Runway Marking (solvent borne)	523	372	331	450	**1.16**	0.83	0.74	50	79	13.7
Protective Coating - Primer/Surfacer(a)	612	395	343	450	**1.36**	0.88	0.76	40	67	18.4
Two Pack Epoxy - Protection of Steel(a)	522	178	147	400	**1.31**	0.44	0.37	80	99	6.7
TOTAL										**38.7**

(a) Exceedances are likely to be a under prediction due to the assessment being based primarily on production rather than 'ready for use' data. Companies providing 'ready for use' coatings data were noted to exceed the limits by a greater margin.

Table 29: Comparison with EU VOC Limits for Architectural & Decorative Paints

	EU limits – Phase 1 (January 2007)					EU limits – Phase 2 (January 2010)				
Product Category	**Phase I Limits (g/l) from 1.1.2007**	**% Companies who Comply**	**% Volumes which Comply**	**Total VOC Reduction Achievable**	**Total Ozone Formation Potential Reduction**	**Phase II Limits (g/l) from 1.1.2010**	**% Companies who Comply**	**% Volumes which Comply**	**Total VOC Reduction Achievable**	**Total Ozone Formation Potential Reduction**
"Heavy end" texture coatings	300	100	100.0	0.0		200	100	100	0.0	
Ceiling Paint/Flat topcoats	75	100	100.0	0.0		30	60	73	38.8	96.7
Door,Window,Trim: solvent-based	400	80	99.8	0.1	0.3	300	0	0	485.3	1261.7
Door,Window,Trim: water-based	150	100	100.0	0.0		130	100	100	0.0	
Exterior topcoats:water-based	75	100	100.0	0.0		40	40	47	193.2	481.0
Fence finishes	150	100	100.0	0.0		130	100	100	0.0	
Interior topcoats: water-based	75	100	100.0	0.0		30	20	39	237.4	591.2
Metal finishes	400	30	17.1	108.9	283.0	300	30	0	258.0	670.7
Prepcoats: solvent-based	450	80	68.1	483.2	1256.2	350	0	0	1366.1	3551.7
Prepcoats: water-based	50	80	60.7	0.2	0.4	30	20	29	1.1	2.8
Roof Paint: solvent-based	400	25	28.4	2.3	6.0	300	0	0	24.4	63.4
Roof Paint: water-based	150	100		0.0		130	100	100	0.0	
TOTAL				**594.6**	**1546.0**				**2604.2**	**6719.1**

Table 30: Comparison with EU VOC Limits for Architectural & Decorative Wood care

Product Category	Volume-weighted Solvent Content (g/litre)	EU limits – Phase 1 (January 2007)			EU limits – Phase 2 (January 2010)		
		Phase I Limits (g/l) from 1.1.2007	VOC Reduction Achievable (tonnes/annum)	Ozone Formation Potential Reduction (tonnes/annum)	Phase II Limits (g/l) from 1.1.2010	VOC Reduction Achievable (tonnes/annum)	Ozone Formation Potential Reduction (tonnes/annum)
Decking Paint: water-based	43	150			130		
Decking Paint: solvent-based	635	400	658.9	1,799	300	939.8	2,566
Flooring: water-based	116	150			130		
Flooring: solvent-based	562	400	96.9	265	300	156.9	428
Interior Stains: water-based	136	150			130	0.4	1
Interior Stains: solvent-based	448	500			400	17.1	47
Exterior Stains: water-based	97	150			130		
Exterior Stains: solvent-based	643	500	38.5	105	400	65.4	179
Prepcoats: water-based	50						
Prepcoats: solvent-based	485						
Interior clears: water-based	136	150			130	1.0	3
Interior clears: solvent-based	450	500			400	32.5	89
Exterior clears: water-based	85	150			130		
Exterior clears: solvent based	425	500			400	0.6	2
TOTAL			**794.4**	**2,168.7**		**1,213.8**	**3,313.7**

6.3 Comparison with EC VOC Limits for Architectural & Decorative Coatings

Results from the assessment of VOC contents (including acetone) estimated for Architectural & Decorative Coatings against EU Phase 1 and Phase 2 limits are given in **Table 29** for paints and **Table 30** for wood care.

6.3.1 Architectural and Decorative Paints and Enamels

It was estimated that 95% (by volume) of Architectural & Decorative paint products are within EU Phase 1 limits. Product types for which exceedances of the EU Phase 1 Limits are calculated include:

- Metal finishes (83% by volume exceed the limit)
- Solvent-based roof paint (72% by volume exceed limit)
- Solvent- and water-based prepcoats (32% and ~40% by volume exceed respectively)
- Solvent-based door, window, trim (only 0.2% exceed)

Given EU Phase 2 limits, the volume of coating products within limits will be reduced to 56% (by volume). Product Types requiring 30% to 50% VOC reduction to meet Phase II limits include:

- Door, Window, Trim, solvent-borne
- Prepcoats solvent based
- Metal finishes
- Roof paint, solvent borne
- Interior topcoats water based
- Exterior topcoats water based
- Prepcoats water based
- Ceiling paint / flat topcoats

Given the total VOC reduction calculated given compliance with EU Phase 1 limits (595 tonnes/annum), and the product-specific MIRs calculated, the total reduction in Ozone Formation Potential is expected to be of the order of 1,550 tonnes/annum. Reductions due to compliance of solvent-based prepcoats is responsible for the bulk of the VOC and reactivity-weighted VOC (81%), followed by metal finishes (18%).

Given EU Phase 2 Limits, all products within the following product types would be required to be brought into compliance: solvent-based door, window, trim coatings, metal finishes, solvent-based prepcoats and solvent-based roof paints. A significant proportion (30% to 70% by volume) of several other product types (ceiling paint/flat topcoats, water-based exterior topcoats, water-based interior topcoats, water-based prepcoats) will also need to have their VOC contents reduced to meet the Phase 2 limits. Product types which currently meet future EU Phase 2 Limits are 'heavy end' texture coatings, water-based door, window, trim coatings, fence finishes and water-based roof paint.

Compliance with EU Phase 2 limits are calculated to represent a total VOC reduction of ~2,600 tonnes/annum and associated reduction in Ozone Formation Potential of 6,720 tonnes/annum. Of the reactivity-weighted VOC reduction, 52% would be due to solvent-based prepcoats, ~20% due to solvent-based door, window, trim and 7% to 10% due to water-based exterior topcoats, water-based interior topcoats and metal finishes.

6.3.2 Architectural and Decorative Wood care

EU Phase 1 VOC limits are exceeded for three solvent-based wood care products, namely: decking paint, flooring and exterior stains. Given the total VOC reduction calculated given compliance with EU Phase 1 limits (794 tonnes/annum), and the product-specific MIRs calculated, the total reduction in Ozone Formation Potential is expected to be of the order of 2,170 tonnes/annum. Reductions are primarily due to decking paint (83%), with reductions due to flooring (12%) and exterior stains (5%) being less significant.

Exceedances of EU Phase 2 (2010) VOC limits are projected for several product types including primarily solvent-borne wood care product types (decking paint, flooring, interior and exterior stains, exterior clears, and to a minor extent exterior clears). Very minor exceedances of the VOC limits also occur for water-based interior stains and interior clears.

Given the total VOC reduction calculated given compliance with EU Phase 2 limits (1,200 tonnes/annum), and the product-specific MIRs calculated, the total reduction in Ozone Formation Potential is expected to be of the order of 3,300 tonnes/annum. Reductions are primarily due to solvent-borne decking paint (77%) and flooring paint (13%).

6.4 Comparison with 'Best Practice' VOC Limits for Architectural Coatings

The Environment Choice Australia is a voluntary labelling standard that aims to identify environmental quality and other criteria that products sold on the Australian market must meet in order to be considered as "best environment practice".

The volume-weighted VOC contents derived for Architectural & Decorative coatings during the study were compared with the VOC limits on architectural coatings covered by Environmental Choice Australia. The main findings were as follows:

- Volume-weighted VOC contents for solvent-based architectural coatings are generally at or in excess of 400 g/litre, significantly higher than the Environmental Choice Australia (ECA) limit of 200 g/litre.

- Volume-weighted VOC contents for exterior water-based topcoats (46 g/litre) were less than the ECA limit for exterior coatings.

- Volume-weighted VOC contents for interior water-based coatings (46 g/litre) were generally above the ECA limits given for interior coatings, e.g. interior flat-ceiling 24 g/litre compared to the 'best practice' limit of 14 g/litre; interior topcoats 31 g/litre compared to 16 g/litre).

The conclusion drawn is that in most instances, volume-weighted actual VOC contents significantly exceeded the "best environment practice" limits.

6.5 Comparison with EU and CARB Automotive Refinish VOC Limits

Both CARB and EU VOC limits apply to ready for use automotive refinish coatings, with reference therefore made to the Product Type data from the study which includes the apportioned hardener and thinners.

Results from the simplistic comparison of VOC contents estimated for Automotive Refinishing Coatings with EU VOC limits are given in **Table 31**. Volume-weighted VOC contents for solvent-borne automotive refinish coatings were predicted to exceed EU limits by factors in the range of 1.4 to 1.8.

Table 31: Compliance with EU VOC limits for Automotive Refinishing

Product Type	Volume-weighted VOC content (g/L)	EU VOC Limit (g/L)	Ratio between Volume-weighted VOC Content and EU Limit	VOC Reduction Potential (tonnes/annum)
1K - Synthetic air dry enamels (Primers)	631	420	1.5	55
1K - Synthetic air dry enamels (Topcoats)	631	420	1.5	61
1K-Primers	732	540	1.4	131
1K-Lacquers-Clear	738	420	1.8	77
1K - Lacquers- Colour Basecoat Effect	759	420	1.8	170
1K - Lacquers - Colour Single Stage	759	420	1.8	170
2K Etch Primer	766	540	1.4	81
2K Epoxy Or Other Primer (non PU)	697	540	1.3	37
2K - Primers - Urethane	587	540	1.1	35
2K - Basecoats	771	420	1.8	698
2K - Topcoats - Clears	587	420	1.4	208
2K - Topcoats - Colour	571	420	1.4	262
TOTAL				**1,987**

The comparison with EU VOC limits and calculated VOC reduction potential given in **Table 31** is simplistic given that manner in which coatings are formulated to meet EU and other limits will determine actual VOC (and ozone formation) reduction potentials.

For example, 1K Lacquers (Clear and Colour) are likely to be phased out under VOC regulations. Paint manufacturers are likely to change technologies under such regulations, eg. Water-borne basecoats, able to meet EU and CARB limits, could replace 2K-basecoats and probably also 1K lacquer colour. Whereas the EU limit for 2k-basecoats and 1k lacquers is 420 g/litre, the replacement water-borne basecoat is likely to have an VOC content of about 80 g/litre, thus representing a more significant reduction than that estimated in the simplistic approach demonstrated in **Table 31**.

Regulations restricting VOC contents of Coatings have typically resulted in the following developments in solvent-borne coatings technology:

- High-solids coatings,
- Increased emphasis on reduced-density solvents, and
- In the US, where certain solvents are exempt, paint formulators make use of exempted solvents to reduce the overall VOC content.

In assessing the VOC reduction potential achievable through the implementation of EU and CARB type limits it was necessary to consider probable ways in which coatings may be reformulated or replaced under these different regulatory regimes. Assumptions regarding possible future coating formulations must take into account (a) differences in the volume of solids, (b) presence/absence of ‘exempt solvents’ and (c) types of solvents likely to be used within coatings. This work was undertaken with the assistance of PPG technical personnel (*personal communication* Paul Addeney and Joe Lister, PPG, December 2008).

Reformulations to meet EU and CARB VOC limits were compiled for the following automotive refinish product types:

- 2K-Basecoats
- 2K-Topcoat Clear
- 2K - Topcoat - Colour
- 1K Lacquer Colour Basecoat Effect
- 1K Lacquer Colour Single Stage

Together these product types account for approximately 64% of both the coating volumes and VOCs estimated for the Automotive Refinish product category (**Figure 27**). The comparison of volume-weighted VOC contents of the above product types with EU limits (ref. **Table 31**) provides a preliminary indication of the potential for VOC reductions which may be realized through the consideration of these product types.

In devising probably formulations of the selected Product Types within the EU and CARB regulatory frameworks, the following assumptions were made by PPG personnel:

- CARB compliance formulations were assumed to exclude water (as per the regulation) and include exempt solvents.
- EU compliance formulations were assumed to include water (as required by the EU regulations).

- The assumed typical and exempt solvents for each formulation derived were as follows:

Technology	Assumed VOC Solvents	Assumed Exempt Solvents
CARB Solvent-borne Basecoat	N-butyl acetate: xylene (1:1)	acetone/ parachlorobenzotrifluoride (1:1)
EU or CARB Waterborne Basecoat	2-butoxy ethanol	NA
EU High Solids Solvent-borne 2K Clearcoat	N-butyl acetate: xylene (3:1)	NA
CARB Solvent-borne 2K Clearcoat	N-butyl acetate: xylene (1:2)	acetone/ parachlorobenzotrifluoride (1:1)
EU Single Stage High Solids Solvent-borne 2K Topcoat	N-butyl acetate: xylene (3:1)	NA
CARB Single Stage Solvent-borne 2K Topcoat	N-butyl acetate: xylene (1:2)	acetone/ parachlorobenzotrifluoride (1:1)
EU or CARB Waterborne Basecoat	2-butoxy ethanol	NA
CARB Solvent-borne Basecoat	N-butyl acetate: xylene (1:1)	acetone/ parachlorobenzotrifluoride (1:1)
CARB Single Stage Solvent-borne 1K Lacquer	N-butyl acetate:xylene:IMS (1:3:1)	acetone/ parachlorobenzotrifluoride
CARB Single Stage Solvent-borne 2K Topcoat	N-butyl acetate: xylene (1:2)	acetone/ parachlorobenzotrifluoride
EU Single Stage High Solids Solvent-borne 2K Topcoat	N-butyl acetate: xylene (3:1)	NA

- VOCs were assumed to have an average density of 0.9.
- Exempt solvents are made up of 50% acetone and 50% Oxsol, and have an average density of 1.07.
- MIRs implemented were as follows: xylene (6.78), acetone (0.43), Oxsol (0.11), butoxy ethanol (2.88) and n-butyl acetate (0.88).
- Likely solid contents (g/litre) were estimated as follows:

Technology	Solids (g/litre)
CARB Solvent-borne Basecoat	230
EU or CARB Waterborne Basecoat	184
EU High Solids Solvent-borne 2K Clearcoat	598
CARB Solvent-borne 2K Clearcoat	414
EU Single Stage High Solids Solvent-borne 2K Topcoat	610
CARB Single Stage Solvent-borne 2K Topcoat	403
EU or CARB Waterborne Basecoat	184
CARB Solvent-borne Basecoat	230
CARB Single Stage Solvent-borne 1K Lacquer	115
CARB Single Stage Solvent-borne 2K Topcoat	403
EU Single Stage High Solids Solvent-borne 2K Topcoat	610

As an example, differences in the composition of standard (uncontrolled) solvent-borne basecoat, CARB compliant solvent-borne basecoat and EU or CARB compliant water-borne basecoat are illustrated in **Figure 33**. In this example, the standard basecoat comprises 810 g VOC/L, the CARB compliant solvent-borne contains 158 g/L non-exempt solvents and 670 g/L of exempt solvents (total of 826 g/L) and the EU/CARB compliant water-borne basecoat contains 126 g/L VOCs.

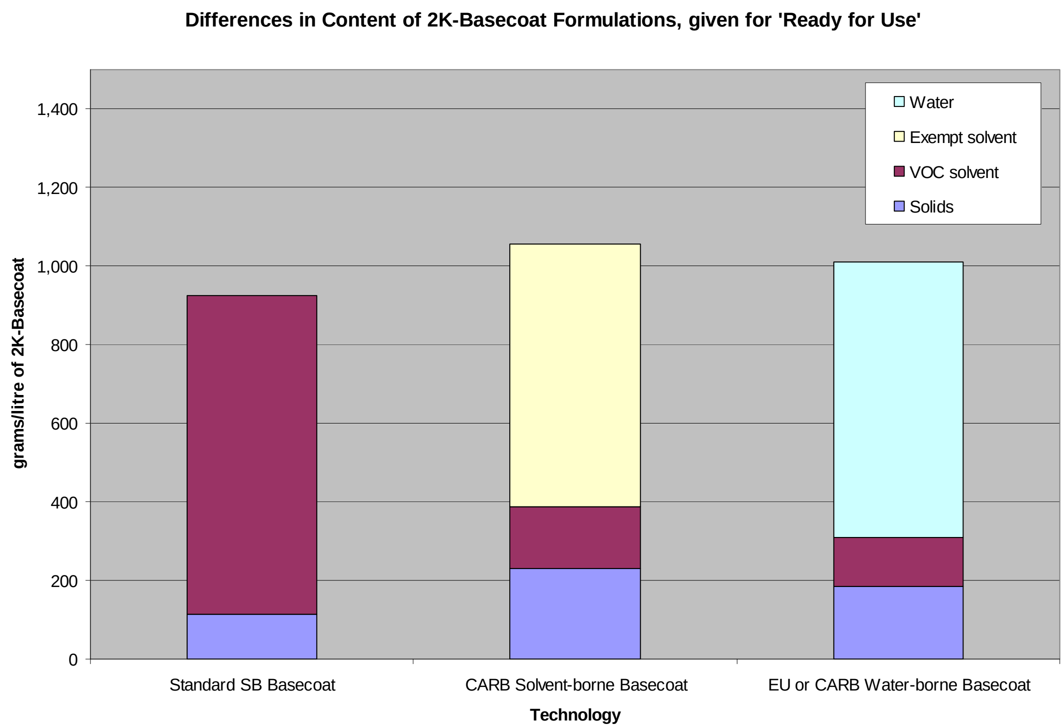


Figure 33: Composition of standard basecoats (uncontrolled VOC contents), CARB compliant solvent-borne basecoats and EU or CARB compliant water-borne basecoats

Reductions in VOC and ozone formation potential (tonnes/annum) achievable through the reformulation of Automotive Refinishing Product Types to meet EU and CARB limits are presented in **Figure 32** and **Figure 33**.

Table 32: Projected changes (reduction/increment) in total VOCs (tonnes/annum) through the predicted reformulation of Automotive Refinishing Product Types to meet EU and CARB VOC limits

Product Type	Volumes (kL, 2007)		Technology			
			Base Case Volume-weighted Average Solvent Borne (this study)	CARB Solvent-borne Basecoat	EU or CARB Waterborne Basecoat	
2K-Basecoats	1,987	Total VOC Content (tonnes)	1,533	821	157	
		VOC Reduction/Increase (tonnes)		- 711	- 1,376	
			Volume-weighted Average Solvent Borne (this study)	CARB Solvent-borne 2K Clearcoat	EU High Solids Solvent-borne 2K Clearcoat	
2K - Topcoats - Clears	1,240	Total VOC Content (tonnes)	728	820	352	
		VOC Reduction/Increase (tonnes)		91	- 377	
			Volume-weighted Average Solvent Borne (this study)	CARB Single Stage Solvent-borne 2K Topcoat	EU Single Stage High Solids Solvent-borne 2K Topcoat	
2K - Topcoat - Colour	1,739	Total VOC Content (tonnes)	993	1,147	479	
		VOC Reduction/Increase (tonnes)		154	- 514	
			Volume-weighted Average Solvent Borne (this study)	CARB Solvent-borne Basecoat	EU or CARB Waterborne Basecoat	
1K Lacquer Colour Basecoat Effect	502	Total VOC Content (tonnes)	381	312	59	
		VOC Reduction/Increase (tonnes)		- 70	- 322	
			Volume-weighted Average Solvent Borne (this study)	CARB Single Stage Solvent-borne 1K Lacquer	CARB Single Stage Solvent-borne 2K Topcoat	EU Single Stage High Solids Solvent-borne 2K Topcoat
1K Lacquer Colour Single Stage	501	Total VOC Content (tonnes)	381	476	166	40
		VOC Reduction/Increase (tonnes)		95	- 215	- 341

Table 33: Projected changes (reduction/increment) in Ozone Formation Potential (tonnes/annum) through the predicted reformulation of Automotive Refinishing Product Types to meet EU and CARB VOC limits

Product Type	Volumes (kL, 2007)		Technology			
			Base Case Volume-weighted Average Solvent Borne (this study)	CARB Solvent borne Basecoat	EU or CARB Waterborne Basecoat	
2K-Basecoats	1,987	Total Ozone Formation Potential (tonnes)	4,116	779	451	
		Ozone Formation Potential Reduction/Increase (tonnes)		- 3,337	- 3,665	
			Volume-weighted Average Solvent Borne (this study)	CARB Solvent borne 2K Clearcoat	EU High Solids Solvent borne 2K Clearcoat	
2K - Topcoats - Clears	1,240	Total Ozone Formation Potential (tonnes)	2,478	923	830	
		Ozone Formation Potential Reduction/Increase (tonnes)		- 1,555	- 1,648	
			Volume-weighted Average Solvent Borne (this study)	CARB Single Stage Solvent borne 2K Topcoat	EU Single Stage High Solids Solvent borne 2K Topcoat	
2K - Topcoat - Colour	1,739	Total Ozone Formation Potential (tonnes)	3,438	1,820	1,131	
		Ozone Formation Potential Reduction/Increase (tonnes)		- 1,618	- 2,307	
			Volume-weighted Average Solvent Borne (this study)	CARB Solvent borne Basecoat	EU or CARB Waterborne Basecoat	
1K Lacquer Colour Basecoat Effect	502	Total Ozone Formation Potential (tonnes)	1,102	296	171	
		Ozone Formation Potential Reduction/Increase (tonnes)		- 806	- 931	
			Volume-weighted Average Solvent Borne (this study)	CARB Single Stage Solvent borne 1K Lacquer	CARB Single Stage Solvent borne 2K Topcoat	EU Single Stage High Solids Solvent borne 2K Topcoat
1K Lacquer Colour Single Stage	501	Total Ozone Formation Potential (tonnes)	1,100	298	263	93
		Ozone Formation Potential Reduction/Increase (tonnes)		- 801	- 837	- 1,006

A synopsis of the total VOC and ozone formation potentials achievable through the implementation of typical CARB compliant solvent-borne products and CARB/EU compliant water-borne/high solids products is as follows:

Technology	Total VOC Reduction (tonnes/annum)	Total Ozone Forming Potential Reduction (tonnes/annum)
CARB compliance solvent-borne	440 - 751	2,930
EU/CARB compliant water-borne and EU compliant high solids solvent-borne	8,118 – 8,153	9,557

Do to the inclusion of exempt solvents in CARB compliant formulations, the potential for reductions in total VOCs is significantly lower than for EU compliant coatings. It is notable that the simplistic approach to estimating VOC reductions due to EU compliance (**Table 31**) underestimated probable VOC reductions by ~30%. It may therefore be anticipated that the VOC (and ozone formation) potential reductions calculated as being associated with bringing Architectural & Decorative Coatings into compliance with EU limits may have been understated.

Due to VOCs with ozone forming potentials being relatively equally controlled under both the CARB and EU regulatory regimes, the potentials for reductions in ozone formation potentials is comparable for CARB and EU compliant coatings, but higher for EU compliant coatings.

6.6 Comparison with Locally Proposed Heavy Duty VOC Limits

Estimated VOC contents were however compared to the set of maximum VOC limits proposed during study consultations by an industry representative, as given in **Table 24**. These maximum VOC limits are based on VOC contents which, it is perceived, could readily be achieved given existing PC, Marine and Yacht coating technology.

The main conclusions drawn from this comparison were as follows:

- Limits proposed for Protective Coatings were more lenient than that given in APAS.
- In terms of Marine, exceedances of the proposed maximum limits were predicted for some companies for tie-coat, topcoat (one component) and wash primer. Reductions to within the proposed limits would reduce VOCs by about 2.5 tonnes/annum.
- For Yacht coatings, tie-coat and wash primers were noted to exceed the proposed limits with VOC reductions of 0.9 tonnes/annum required to meet the limits.
- Protective Coating limits were estimated to be exceeded marginally (by one company) for wash primer with no significant reduction in VOC likely if limits were to be met.

A total VOC reduction of ~3.4 tonnes/annum was estimated to be achievable if coatings complied with the proposed coatings. Scaled up to reflect the entire industry this would be a reduction of about 5.8 tonnes/annum.

7 Environmental Benefits and Risks

Reductions in Ozone Formation Potentials achievable, and possible Product Categories and Types to be targeted in this regard, are assessed in this section. Contributions to total sector reactivity-weighted VOCs and international regulatory practices are taken into account.

Broader environmental benefits and risks associated with controlling the VOC content of surface coatings are briefly explored.

7.1 VOC and Ozone Formation Potentials associated with Surface Coatings

Total VOCs within surface coatings sold in Australia in 2007, excluding VOCs within 'source controllable coatings', was estimated to be approximately 36,500 tonnes.

The ozone formation potential was predicted to be a factor of 2.9 greater at 106,270 tonnes/annum, taking into account the reactivities of specific VOCs contained within individual product types.

7.2 Contribution of VOCs from Surface Coatings to total Anthropogenic VOCs

Total anthropogenic VOC emissions are estimated to be of the order of 800 kilo tonnes/annum, based on the National Pollutant Inventory (NPI, 2007). The potential contribution of surface coating VOCs estimated in this study to total anthropogenic VOC emissions was estimated to be of the order of 5%.

7.3 Targeted Reduction of VOC and Ozone Formation Potentials

Key factors taken into account in identifying Market Segments, Product Categories and Product Types for which the greatest VOC and Ozone Formation Potential reductions could potentially be achieved were as follows:

- Contribution of Market Segments / Product Categories / Product Types to total VOC Content and Ozone Formation Potential of surface coatings (as documented in **Section 5.2**).
- Market Segments and Product Categories and Types routinely targeted locally and internationally through product-based VOC limits (Ref. **Section 6**).
- Reductions in VOC and Ozone Formation Potentials achievable given compliance with current local and international VOC limits.

Differences in the relative contributions of Market Segments to VOC emissions and ozone formation potentials are smaller than anticipated and do not provide a clear basis for prioritization of Market Segments (**Figure 22** and **Figure 23**). It does however highlight Product Categories which are larger contributors, such as Architectural & Decorative Paints and Automotive Refinishing, followed by Industrial Finishing Coats and Protective Coatings (**Figure 24**).

Product Categories routinely targeted by VOC limits are:

- Architectural & Decorative Paints and Wood care
- Automotive Refinishing
- Industrial and Protective Coatings (most notably road marking paint, protective coatings for steel and other industrial maintenance coatings, industrial wood care)
- Marine and Yacht (CARB, proposed Hong Kong)

Reductions in VOC and Ozone Formation Potentials which may be achieved given compliance with available local and international VOC limits was estimated where possible (**Section 6**), a synopsis of which is given in **Table 34**.

Table 34: Estimated Reduction in VOC Emission and Ozone Formation Potentials given compliance with Local and International VOC Limits

	Total VOC Reduction Achievable (tonnes/annum)			
	Architectural & Decorative Paints/Enamels	Architectural & Decorative Wood care	Automotive Refinishing	Industrial & Protective Coatings
APAS	249	0		39
EU limits – Phase 1 (January 2007)	595	795	2,930	
EU limits – Phase 2 (January 2010)	2,604	1,214		
CARB limits (January 2009)(a)			440 – 1,668	
	Total Ozone Formation Potential Reduction (tonnes/annum)			
	Architectural & Decorative Paints/Enamels	Architectural & Decorative Wood care	Automotive Refinishing	Industrial & Protective Coatings
APAS	631	0		171
EU limits – Phase 1 (January 2007)	1,546	2,169	9,557	
EU limits – Phase 2 (January 2010)	6,719	3,314		
CARB limits (January 2009)(a)			8,118 – 8,606	

(a) Range given to indicate reduction achievable using CARB compliant solvent-borne coatings only (lower reductions) or a combination of CARB compliant solvent- and water-borne coatings.

The main findings regarding the potential for VOC / Ozone Formation Potentials reductions achievable are as follows:

Architectural & Decorative Paints

- Modest reductions are likely to be achieved by bringing all Architectural & Decorative Coatings in line with APAS and EU Phase 1 Limits (250 to 600 tonnes of per annum, representing 3% to 6% of the total VOCs of this Product Category).

  This is due to the progressive increase in water-borne coating usage and decline in solvent-borne coatings within the Architectural & Decorative market, with voluntary reductions by industry through the APAS scheme serving to reinforce VOC reductions.

  Of the 70% by volume of Architectural & Decorative Paints covered by APAS limits, 98% by volume currently comply with maximum APAS VOC limits.

EU VOC limits cover ~100% by volume of Architectural & Decorative Paints, with 95% by volume of coatings currently in compliance with EU Phase 1 limits.

- Reductions to be achieved by bringing all Architectural & Decorative Coatings in line with EU Phase 2 Limits are more significant, estimated to be at least ~2600 tonnes VOCs/annum, representing 28% of the total VOCs of this Product Category.

  This is a conservative estimate of the VOC reduction as it is anticipated that certain solvent-borne technologies will be replace with alternative technologies (e.g. water-borne; high solids) so reducing the VOC content to well below the solvent-borne VOC limit. For example, the adoption of a 300 g/litre 2010 limit for solvent-based trim coatings will most likely result in the demise of the whole product group given the absence of existing solvent-based technology locally to meet this limit. This will result in the sales volume moving to water-based trim, with an overall reduction in VOC content from 400 to 130 g/L, so resulting in VOC and O_3 formation potential reductions in excess of that calculated (*personal communication*, Alan Kesby, PPG, November 2008).

- Individual Architectural & Decorative Product Types which potentially warrant attention in terms of their contributions are:

  - Solvent-borne coatings such as trim, prepcoat and metal finishes.

  - High volume water-borne coatings, eg. Interior and exterior water-borne topcoats. (Small reductions in VOC content could result in significantly lower VOC emission potentials due to the volume of such coatings used.)

Architectural & Decorative Wood care

- Architectural & Decorative Wood care Product Types which potentially warrant attention in terms of their contributions to total VOC emission potentials are solvent-borne wood care coatings, notably decking paint and to a lesser extent flooring, stains and clears.

- VOC reductions achievable by meeting EU limits are projected to be in the range of 9% in terms of Phase 1 limits and 13% given compliance with Phase 2 limits. Such reductions would almost entirely derive from solvent-based wood care products, with solvent-borne decking paint representing the most significant contributor to VOC reduction potentials (~80%), followed by solvent-borne flooring wood care (~13%).

Automotive Refinishing

- More significant reductions are achievable from the Automotive Refinishing sector. The extent of such reductions is to a large extent dependent on the nature of the regulatory framework which drives technologies implemented, eg. high solids, water-borne, solvent-borne with exempt solvents.

  Compliance with EU limits (within the EU regulatory framework) is predicted to result in VOC reduction of about 2,900 tonnes/annum. This would represent a 46%-48% reduction in the VOC / Ozone Formation Potential associated with this sector.

Compliance with CARB limits (within the US regulatory framework) is estimated to result in a total VOC reduction in the range of 440 to 1,670 tonnes/annum, depending on the technologies selected by paint manufacturers to meet limits. This VOC reduction represents a 7% to 26% reduction in total VOCs within this sector. The more moderate reduction in total VOCs, compared to the EU compliance scenario, is due to the use of exempt solvents under the US/CARB regulatory frameworks.

Reductions in ozone formation potentials given CARB compliance will be more marginally lower than that likely under EU regulations, representing a 40% to 43% reduction in the ozone formation potential of the sector. This is due to the exempt solvents used in coatings having very low reactivities (hence their exemption).

- It is interesting to note how the range of estimated emission reductions in total VOCs from the Australian automotive refinishing sector (approximate 450 to 3,000 tonnes/annum reduction from baseline VOC emission estimate of about 6,400 tonnes/annum) compares to the estimated reduction in VOC emissions estimated by other countries, eg:

    - Environment Canada (2005) – estimated VOC reductions from automotive refinishing of about 2,000 tonnes/annum based on 2002 figures.

    - CARB (2005) – estimated VOC emissions from automotive refinishing of about 7,600 tonnes/annum during 2002, with VOC emission reductions of 2,600 tonnes/annum (representing a 35% reduction).

    (Note: In estimating emission reductions CARB and Environment Canada excluded exempt VOCs, whereas such VOCs were included in the total VOCs for the purpose of the current study.)

- Questions have been raised regarding the potential for actual VOC emission reductions at Auto Refinish Shops, given the range of cleaning and coating steps during typical smash repair operations.

  Information was received from one major automotive refinish manufacturer regarding VOC emissions associated with the use of solvent-borne coatings and associated cleaning products compared to emissions from the use of low VOC / water-borne coatings and associated cleaning agents. VOCs were given for various process steps within a typical smash repair operation, including washing and degreasing, existing paint removal, application and sanding of body filler, applications of adhesion primers, coating applications (various) and gun cleaning (etc.). These data supported the following findings:

    - VOC emission reductions due to the use of low VOC / water-borne coatings and associated pre-treatment and cleaning products were estimated to be in the range of 55% to 65% across the typical process steps. Low VOC coatings specifically were estimated to be associated with 60% lower VOC emission potentials. (This result is comparable to results published by Entec, 2000, that reductions in VOC emissions from body shops using >2 tonnes per annum solvent could be in the order of 57%.)

- o Gun cleaning at various stages during the process was a significant source of potential VOC emissions during both the solvent-borne and low VOC coating applications. Although water-borne gun cleaners could be used during certain stages of the water-borne coating application, there was still indicated to be a need for solvent-borne gun cleaners during other stages of such applications (eg. cleaning of gun following high build filler application).

- o Within the low VOC coating application, 50% to 75% of the potential VOCs were associated with gun cleaning, 15% to 30% with the coating applications (water-borne basecoat and low VOC clearcoat) and 10% to 20% with filler applications. A similar apportionment of VOC emission potentials was apparent for the solvent-borne coating application, although actual emissions were higher than for the low VOC coating application.

Industry & Protective Coatings

- Based on their contributions to total VOCs the following Protective Coatings may be worthy of further attention: topcoats, 2k epoxy, primers and zinc rich coatings.

- Industrial product types which contribute significantly to total product coating emissions are solvent-borne baking enamel finishing coats and solvent-borne industrial wood care products. Baking enamel is however likely to be used within factory operations that are controllable.

- VOC limits are typically specified for road marking paint (solvent and water-borne), protective coatings for steel and epoxies.

- Based on the assessment of VOC reductions realizable through meeting APAS limits for road & runway marking coatings, PC primers/surfacers, and 2K epoxy for steel protection, it was concluded that only minor VOC reductions are likely (40 tonnes/annum, <1% of Industrial and PC VOCs)

Marine and Yacht

- Based on their contributions to total VOCs from their respective Product Categories the following Product Types may be of interest:

  - Marine – Anti-fouling, topcoats, 2k epoxy, tie-coats

  - Yacht – anti-fouling, primers, extreme high gloss

- A preliminary analysis indicated that relatively small VOC reductions were achievable through meeting locally proposed maximum VOC limits, and even onerous international VOC limits (CARB, proposed Hong Kong). This is due primarily to the limited volumes used, and the relative unavailability of low VOC technologies to replace certain of the solvent-borne coatings which are currently in use.

7.4 Environmental Benefits of Product-based VOC Regulation

7.4.1 Reductions in Tropospheric Ozone

The limitation of the VOC content of surface coating products has been estimated locally and internationally to deliver significant reductions in VOC emission and, hence, in ozone formation potentials.

Based on the study findings it is estimated that ozone formation potentials reductions of over 13,000 tonnes O_3/annum could be achieved through compliance with local VOC limits and currently in force EU (Phase 1) limits.

Potential benefits associated with the lowering of ground level ozone concentrations include reductions in the potential of the following ozone-related impacts:

- Health effects due to ozone exposure, which include deaths brought forward and additional respiratory hospital admissions.
- Effects on materials, specifically damages to man-made materials including natural and synthetic rubber, surface coatings (paints, varnishes) and textiles, metal and stone.
- Effects on crop production, eg. leaf injury, growth and yield reductions, altered sensitivity to other stresses such as frost tolerance and damage from pests.
- Potential changes in ecosystem functioning in natural vegetation communities.

Such benefits have not been quantified for Australia. Studies undertaken in the UK provide an example of the potential extent of environmental benefits arising due to reductions in VOC levels in coatings. The UK Department for Environment Food and Rural Affairs (DEFRA, 2005) quantified potential reductions in health and environmental impacts and associated cost savings due to the implementation of EU VOC limits for paints, varnishes and vehicle refinishing products. Cost savings associated with benefits were estimated to be in the range of £700 million to £30,000 million in 2010.

7.4.2 Other Environmental Benefits

The limitation of the VOC content of surface coating products may also have a range of other associated environmental benefits including:

- Improvements in indoor air quality;
- Reduced risk of occupational exposures within work environments where coating products are applied;
- Reduced potentials for ambient air quality and odour impacts in the vicinity of coating users (eg. Smash Repairers); and
- Environmental impacts and risks associated with the manufacture of solvents, and with the disposal of coating containers and waste coatings.

Automotive refinish coatings, for example, contain several toxic air contaminants such as toluene, xylenes and methyl ethyl ketone (MEK). Currently, these three compounds account for over 35% by volume of the VOC within the automotive refinish coatings used in Australia. To the extent that these are reduced by the reformulation to lower VOC coatings, there could be a substantial decrease in air pollutant emissions. Given that many automotive refinishing facilities are located in close proximity to residential areas, reduced emissions of such toxins would realize reductions in health risk potentials.

The control of VOCs is therefore expected to generate environmental and health benefits that could be translated into economic terms, eg. avoided costs to the health care system. It is however noted that the total environmental improvements are difficult to establish in quantitative terms, given the information currently available.

Although the monetary benefits of VOC reductions within Australia have not been quantified, it is pertinent to consider the benefits from VOC emission reductions estimated in the US and EU (**Table 35**).

Table 35: Estimated benefits from VOC emission reductions

Source(a)	Low and High Estimates of Benefits due to VOC Reductions (AUD / tonne VOC)
U.S. Office of Management and Budget (2004)	\$1,000 - \$4,700
European Union (2002)	\$1,000 – \$14,000
U.S. EPA (1998)	\$8,300 - \$22,900

(a) References sited in Environment Canada (2008), including:

- US Office of Management and Budget (2004). Informing Regulatory Decisions: 2004 Draft Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local and Tribal Entities, December 2004.
- EU (2002). The Costs and Benefits of the Reduction of Volatile Organic Compounds from Paints, Final Draft, May 2 2002.
- US-EPA (1998) Marginal damage Estimates for Air Pollutants, *Federal Purchasing categories Ranked by Upstream Environmental Burden: An Input/Output Screening Analysis of Federal Purchasing*.

It is noted that differences in weather patterns, product use, land use, population, population density, architectural value and socio-economic conditions make the application of these monetized benefits inappropriate for application within Australia. It is however useful to compare the magnitude of the estimated benefits from VOC emission reductions to the cost-effectiveness of implementing VOC limits within the US and Europe as discussed in the subsequent section.

7.5 Environmental Risks of Product-based VOC Regulation

7.5.1 Uncertainties in the Extent of Tropospheric Ozone Reductions

Several factors which make the determination of achievable reductions in actual tropospheric ozone concentrations uncertain are as follows:

- VOC emissions are assumed equivalent to the VOC content of all coatings which are used outside of areas identified as being controlled or potentially controlled. It is however noted that a proportion of certain coating types may be used in controlled environments. (Eg. 20% of automotive refinishing coatings are estimated to be used within the commercial refinish sector, the operations of which are controlled. Furthermore, a portion of these coatings are applied in smash repair operations with spray booths equipped with activated carbon filtration for VOC removal.)

- The location and timing of coatings use and VOC emissions will determine actual tropospheric ozone formation, with such formation also being dependent on site-specific conditions in terms of meteorology, topography, other source emissions, ambient air quality (specifically ambient NO_x, O_3 and VOC concentrations), etc.

The study provides an estimate of ozone formation potentials based on the application of MIR values, which represents a widely accepted method. Detailed emission inventories and photochemical modelling would however be required to accurately predict likely changes in the number of high ozone days within Australian urban areas.

7.5.2 Potential Increments in VOC Emissions

In California, members of industry identified several areas of potential concern that they believed could result in increased indirect VOC emissions due to a requirement to lower the VOC content of architectural coatings:

- The use of lower-VOC coatings will result in a thicker film coating;

- The use of lower-VOC coatings will result in excessive thinning of coating;

- The use of lower-VOC coatings requires the use of additional primer for proper adhesion to the substrate;

- Lower-VOC coatings will require the use of more coats;

- The use of lower-VOC coatings will require more frequent recoating, touch-up and repair work;

- The use of lower-VOC coatings will result in product substitution by end-users; and

- The use of lower-VOC coatings may result in coatings with higher reactivity.

In response CARB evaluated manufacturers' product data sheets and available testing data for low-VOC coatings. These coatings were found to have substrate preparation, coverage rates and performance similar to their higher VOC counterparts without the need for excessive thinning. In addition, low-VOC coatings were available to avoid substitution. The total reactivity of the lower-VOC architectural coatings was shown to be less than the reactivity of higher-VOC architectural coatings. On these grounds CARB concluded that the indirect increased VOC emissions, if any, from these areas of concern would be insignificant (CARB, 2007).

In the case of specialised products where shifts to lower VOC technologies could adversely impact the technical performance of the product (e.g. durability, reduced protection against corrosion), actual increments in VOC emissions could occur over the long term.

A water-borne acrylic paint, for example, might seem like a sound environmental choice for steelwork until the long-term impacts are carefully considered. In coastal environments, the coating would probably last months rather than years, resulting in frequent repainting to control corrosion. A balance is therefore needed between initial VOC emissions and substrate protection and durability, also taking into account the frequencies of reapplications needed.

It is for this reasons that paint manufacturers have motivated that life cycle analysis be undertaken for high performance products prior to the specification of VOC limits for such products.

7.5.3 Environmental Risks related to Substitute or Exempt Solvents

Concerns have been raised regarding the potential for increased use of low reactivity solvents which may be hazardous in terms of other aspects of the environment.

For example, companies in southern California began formulating with 1,1,1 trichloroethane in the 1980s, a VOC exempt solvent with satisfactory properties and a fast evaporation rate. This chlorinated solvent was however subsequently found to be an ozone-depleting substance and its production and use largely curbed by 1996.

Due to lessons learned, environmental assessments which take into account toxicology, global warming potential, ozone depletion potential (etc.) are currently undertaken for exempt solvents in the US. Parachlorobenzorifouride (PCBTF, Oxsol), acetone and t-butyl acetate (TBAC) represent exempt solvents that have potentially the greatest applicability in architectural coatings. Acetone is frequently used in clear wood coatings and traffic paints. Other exempt solvents such as perchloroethylene and methyl acetate, have much lower potential for use in architectural coatings due to their toxicity or evaporation characteristics.

Questions have been raised regarding health risks due to widespread excessive use of exempt solvents. Whereas effective air toxics management regulations and resources are in place in the US to act as a safety net in such instances, Australia is less well equipped to regulate air toxics once they occur.

The EU regulatory framework, which controls total VOCs, has been viewed as being potentially less risky from an environmental perspective.

7.6 Conclusions

Following a qualitative assessment of environmental benefits and risks it is evident that the successful management of the VOC content of surface coatings, whether through voluntary measures or regulation, is expected to provide an overall environmental benefit.

Environmental risks primarily arise due to the manner in which VOCs are managed or regulated. Risks related to poor performances of reformulated or alternative technologies can, for example, be avoided through undertaking life cycle assessments for high performance products and/or by possible exempting such products from VOC limits. Similarly, caution could be adopted in the exemption of certain solvents if a regulatory approach similar to the US was adopted. Alternatively, total VOCs could be limited as per the European approach without provision made for exempt solvents.

The potential for adverse environmental impacts due to the introduction of VOC limits for surface coatings has been studied by the US-EPA, CARB and the EC. In all cases, the environmental benefits of VOC limits were concluded to offset any adverse environmental impacts. Potential effects studied in the case of CARB (2005) included impacts on air quality, water demand, water quality, public surfaces, transportation and circulation, solid waste, hazardous waste, hazards to the public and environment.

8 Economic and Technical Feasibility

Having evaluated the environmental benefits and risks of limiting VOCs within surface coatings, and noting that environmental benefits are achievable, it is pertinent to consider the technical and economic feasibility of realising VOC reductions in line with international good practice.

Detailed technical feasibility studies are designed to assure that reformulation technologies will be available by the effective date for each proposed limit and that the overall performance of complying products will be similar to that of non-complying products. It is evident that such studies need to be conducted once more certainty exists regarding the likely regulatory framework and the limits and compliance timeframes to be proposed. Economic assessments similarly require more information about the proposed regulatory or other regime.

The study scope does not include detailed technical and economic assessments, but rather requires the review of qualitative technical and contextual information about different product categories to assist consideration of policy options to lower VOCs for such categories.

No documentation could be found regarding the challenges of reducing the VOC contents of locally manufactured products. To fulfil this study requirement it was necessary to consult with paint manufacturing company representatives regarding internal investigations and changes already instituted and to make reference to international experience.

A summary of the most pertinent information collated is presented in this section. Given the potential for VOC reductions within the Automotive Refinishing and Architectural sectors, and these sectors being the focus of VOC regulations internationally, emphasis is placed on their evaluation.

NOTE: In the interpretation of the economic study findings presented in the report, the following should be noted:

- The cost efficiency of measures are expressed in terms of overall costs (dollars) per tonne of VOC reduced, with costs reflecting expenses incurred due to measure implementation less the savings (benefits) realised by the VOC reduction. The costs quantified primarily cover capital and operating costs incurred by coating manufacturers and end users. The benefits costed include health cost savings and other such externalities, which mainly accrue to other parties.

- Economic study findings from abroad are presented to demonstrate the relative significance of cost impacts for affected parties. Costs and impacts concluded by the US-EPA, CARB and in EU studies as being “negligible”, “minimal”, “low”, “cost-effective” (etc.) reflect the economic contexts within which the studies were conducted. Caution should be adopted so as not to transfer such conclusions to the Australian case without further investigation and qualification, particularly given the recent economic downturn.

8.1 Overview of Technological Developments

8.1.1 International Developments

Internationally, regulatory demands on the coatings industry have resulted in the development of new formulating strategies to meet air quality regulations. In terms of product-based changes such strategies have generally included:

- Selection of an alternative coating technology such as water-based, powder or UV cured.
- Reformulating current solvent-borne coatings using higher solids, alternative solvents, solvent blending.

The typical solvent content of various coating technologies are illustrated in **Figure 34**.

Recent developments in solvent-borne coatings technology have included high-solids coatings and increased emphasis on reduced-density solvents.

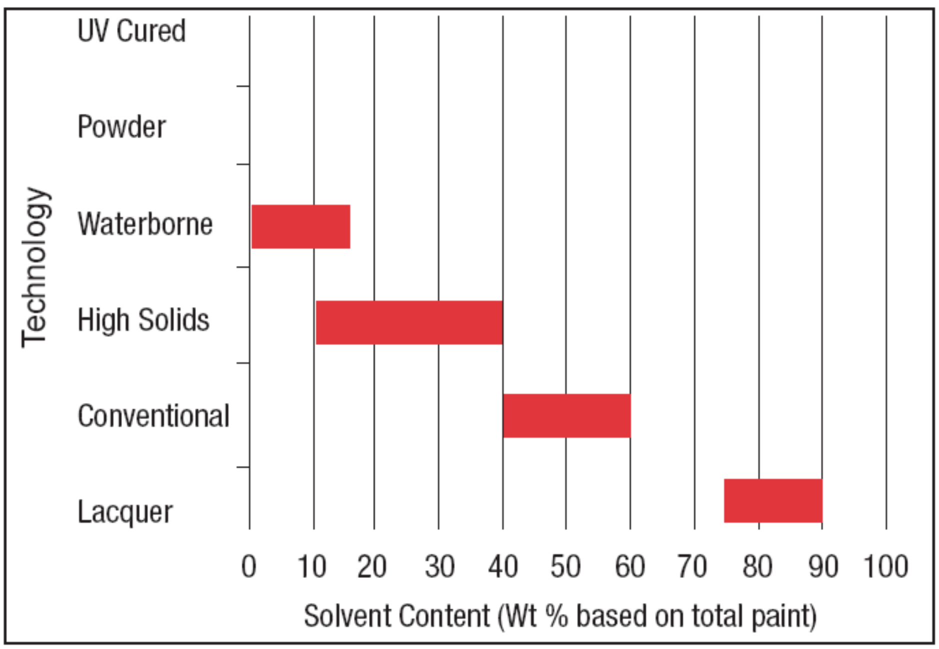


Figure 34: Typical solvent contents of coating technologies (after Eastman, 2004).

Radiation Curing

Radiation curing (UV or electron beam) liquid coatings suitable for spray application are commercially available and typically used in the printing and wood finishing industries (Entec, 2000). Clear UV coatings have been applied to automotive components during manufacture.

Powder Coatings

Powder coating is a type of dry coating which is applied as a free-flowing dry powder. The main difference between powder coatings and conventional liquid paint is that the powder coating does not require a solvent to keep the binder and filler parts in a liquid suspension form. The coating is typically applied electrostatically and then cured under heat to allow it to flow and form a film.

Powder coating is mainly used for coating of metals, aluminium extrusions, and is used in original vehicle manufacturing. Due to the need for high temperature (150℃ to 180℃ metal temperatures) curing to achieve satisfactory films, powder coatings are not used in automotive refinishing.

Water-borne Coatings

Water-borne coatings are formulated with water as the primary solvent or diluent for the binder. Although organic solvent is replaced by water, water-borne coatings are rarely totally free of organic solvent with a small portion of organic solvent being required to render the binder soluble or dispersible in the aqueous phase and to affect pigment wetting.

Binders used in waterborne systems are of a similar type to those of solvent-borne paints in order to give comparable service properties. The resins are however modified to render then water soluble or dispersible (Entec, 2000).

High-solids Coatings

A popular approach implemented by coating manufacturers to reduce solvent emissions was the development of high-solids coatings. The selection of the correct solvent balance was found to be crucial to the successful application of high-solids coatings. This required the increased use of oxygenated solvents such as ketones to achieve the proper application viscosity at the required VOC limits (Eastman, 2004).

Low Density Solvents

Given that various countries, including the US, chose to reduce solvent emissions by limiting the grams of solvent per litre of coating (or pounds of solvent per gallon of coating), the density of the solvent has also become a very important formulating parameter.

Solvent density can have a significant influence on the final VOC content of a coating. Solvents with low density and high activity (ie. low solution viscosity at a given VOC content) were found to be necessary in order to assure suitable spray characteristics at the desired VOC level (Eastman, 2004).

Formulating Lower VOC Coatings

As VOC limits for various coating categories have become increasingly stringent, formulators of solvent-borne coatings have had to further reduce the solvent content to meet existing or pending regulations or adopt alternative technologies. The general approaches adopted have varied depending on the regulatory framework.

In Europe, the control of total VOCs, has driven a trend towards water-borne coatings and high solid coatings with oxygenated solvents. In the US, where VOC limits excluded non-reactive solvents, emphasis is placed on the reformulation of solvent-borne coatings by using VOC exempt solvents and/or by selecting solvents with maximum solvent activity for the paint (resin(s) system (Eastman, 2004).

Low VOC High-Solids Coatings

Further reductions in the VOC content of high-solids coatings, while maintaining optimal coating performance, require a combination of approaches. The most practical reformulation option to reduce the VOC content is through the optimization of the solvent blend. If this approach is not adequate, other steps which are often considered include (Eastman, 2004):

- Modifying resin architecture (molecular weight and molecular weight distribution, minimizing amount of functionality and groups contributing to hydrogen bonding).
- Adding reactive diluents or plasticizers.
- Choosing pigments with low specific gravities and low oil absorption values.
- Re-evaluating cross linker choice and levels.
- Selecting solvents with low density and the ability to minimize resin interactions
- Using VOC exempt solvents (in the case of the US)

With the introduction of increasingly stringent VOC limits, paint formulators are no longer able to add solvents that contribute marginally or not at all (diluents) to the activity of the blend. The efficiency of each solvent must be maximized to achieve the maximum viscosity reduction at a given VOC content. Oxygenated solvents, having low density and high activity, are the most useful in reducing the VOC level of a coating. Ketones have evolved as key components in developing high-solids coatings suitable for meeting the more restrictive VOC limits.

Formulating Coatings with VOC-Exempt Solvents

In the US, paint formulators make use of exempt organic compounds such as PCBTF (Oxsol), acetone, methyl acetate and methylated siloxanes to reduce the overall VOC content of existing solvent-borne coatings.

Whereas the European approach of controlling total VOCs has resulted in the demise of certain traditional technologies (eg. lacquers), the life of such technologies has been extended in the US due to the VOC exemptions of organic compounds such as acetone, methyl acetate and PCBTF.

Lacquers are considered by certain players in the paint industry to be user-friendly and easy to apply and repair. Under the US regulatory framework, lacquers are still used, with compliance with US VOC limits being met despite the high solvent levels of such lacquers.

(Questions were raised locally in discussion with automotive paint manufacturers about the quality of lacquers reformulated with exempt solvents.)

Photochemical Reactivity-based VOC Regulation

The relative range of MIR values for various families of solvents are illustrated in **Figure 35**. Traditional solvent-borne coatings often contain aromatic hydrocarbons such as toluene and xylene which are characterized by high MIR values. The relatively lower MIR value of oxygenated solvents such as ketones which are used in high-solids coatings is worthy of note.

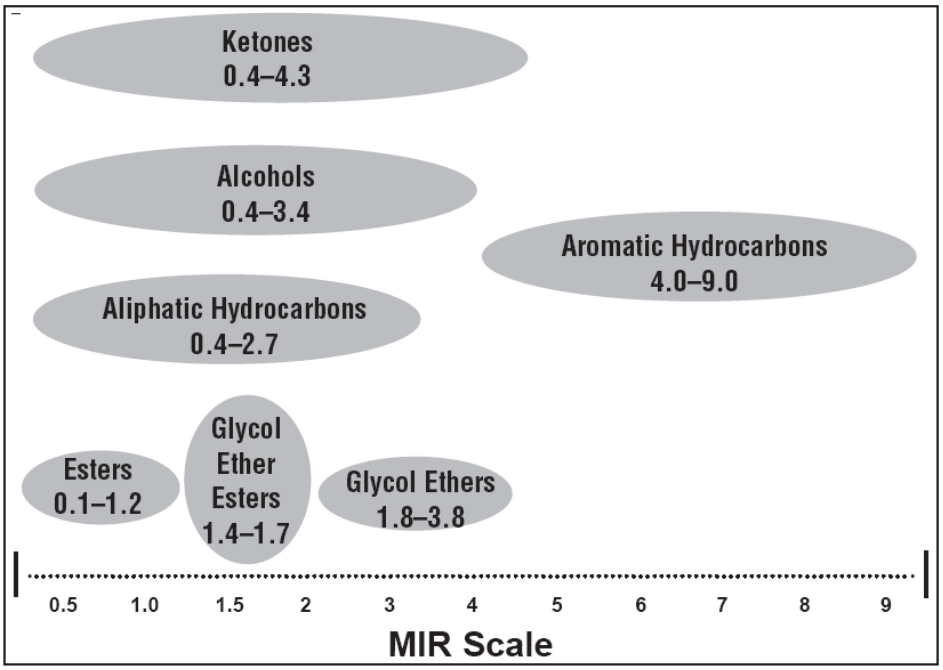


Figure 35: MIR values for coating solvents (after Eastman, 2004)

CARB established the first photochemical reactivity-based limits for regulating ozone formation from aerosol coatings in 2001. This regulation replaced the traditional mass-based VOC emission guidelines and was strongly supported by the aerosol coatings industry which found the new limits much easier to meet than the mass-based limits (Eastman, 2004).

Enforcement challenges currently facing CARB in the implementation of its reactivity-based aerosol coatings regulations include:

- Industry needs to supply coating formulation data, with data quality needing to meet higher standards than previously applied.
- More careful quality control is required to account for batch variability

- Care must be taken in terms of ingredient 'shopping', with attention paid to the purity of ingredients and substitutions for ingredients.

The main reasons given by CARB (2007) for not reverting to reactivity-based VOC regulations for architectural coatings are as follows:

- Districts expressed concerns that implementation of a reactivity-based rule would require additional resources for enforcement, including the need to obtain detailed chemical formulation data.

- Only some industry representatives have been supportive of a reactivity-based approach, with no consensus regarding reactivity-based limits having been achieved among coating manufacturers.

- The US-EPA expressed concerns about how a reactivity-based provision, in addition to a general mass-balance approach, would be enforced and about potential complications that could arise from case-by-case reactivity-based limits adopted by individual districts.

Reactivity-based limits for regulating the ozone formation potentials of coating products, other than aerosols, are not currently implemented internationally. CARB (2007) has however indicated that it would continue research into the use of reactivity-based limits for the VOC regulation of coatings.

8.1.2 Australian Developments

Changes in technology have progressed slowly in the Australian paint industry, with the most significant technology shift in the past 30 years being the decline of solvent-based paint production in favour of water-based paints due to growth in environmental concerns over solvent emissions (IBISWorld, 2008).

Technologies currently in use according to the APMF include:

- improved low solids (<70%), solvent-based systems
- high solids (>70%), solvent-based systems
- water-borne coatings
- reactive (two-part catalysed) systems
- powder coatings, and
- radiation cured systems (ultra-violet and electronic beam).

The shift away from solvent-based paints has been accelerated by developments in radiation curing systems, powder coatings and high solids. These systems are growing at rates of 5% to 8% per annum (APMF, undated; IBISWorld, 2008).

A further technological development involves the use of nanotechnology to develop photocatalytic and self cleaning paints. It is anticipated that the application of this technology would be accelerated by stringent VOC regulations (IBISWorld, 2008).

Several of the international players started the process of reducing VOCs in their products several years ago to meet regulations in the US and/or Europe. This has included the investment in new research and development, the development of new technologies and reformulation of certain products, making available water-borne and high-solids products, and the updating of technical data sheets.

Certain Australian-owned manufacturers have also invested in managing the VOC content of their products, with certain manufacturers also managing their solvent usage to ensure low product MIRs.

The main drivers for change have been noted to differ significantly across market segments within the Australian surface coatings industry:

- The *market* represents a significant driver in the Architectural and Decorative segment, with market trends largely having been responsible for technology shifts and resultant VOC reductions.
- Despite the local availability of low VOC coatings within the Automotive Refinishing segment, the uptake of such coatings has been negligible. It is recognised by the manufacturers of such coatings, that VOC *regulation* would be required to drive the uptake of low VOC coatings.
- *Global trends* represent the most significant driver for changes within the Marine and Yacht Product Categories.

8.2 Automotive Refinishing

8.2.1 Local Context

The Automotive Refinish market is primarily supplied by global paint companies with major product platforms formulated to meet EU or US regulation. This is important for two reasons:

- Global companies are likely to have more ready access to existing low-VOC technologies. This was confirmed in discussion with such companies. Low VOC technologies are considered to be readily available for import according to representatives of the major paint companies.
- Harmonisation of VOC regulations with global markets is a key priority of the global paint companies operating locally. In addition to negatively impacting their businesses, global paint manufacturers cautioned that stipulation of Australia-specific regulations and exclusion of US and/or EU compliant products would restrict access to global, low VOC technologies.

The main low VOC coating technology alternatives applicable for automotive refinishing are water-borne, high solids and reformulated solvent-borne coatings with substitution by low reactivity (exempt) solvents. Despite such technologies being available for import, take up within the Australian market has been low.

Higher costs, perceptions that low VOC technologies performed more poorly than conventional coatings, and the absence of VOC regulations was identified by automotive refinish coating manufacturers as being responsible for the poor uptake of low VOC products. The control exerted by insurance companies on the pricing of smash repair shop operators was noted. *VOC regulations were perceived to be required to effect changes in pricing and to drive uptake.*

There are on-going trends towards rationalisation and aggregation within the smash repair sector. It is estimated that about 4500 body shops are currently in operation nationally, and that this will reduce to 3000 in 3 to 5 years time due primarily to pressure from insurance companies for greater efficiency and improvements in anti-collision road technology.

It was estimated by automotive refinishing manufacturers that 60% to 70% of smash repairers would be negatively impacted by switching to exclusively EU compliant products in the short term. Such manufacturers however agreed that smash repairers should not be exempted from the use of low VOC technology coatings. This would be counter-productive as these operations are significant sources of VOC emission with few of them having effective VOC controls in place.

Certain topcoats, such as topcoats with scratch resistant capabilities, were identified by industry representatives as requiring possible exclusion from product-based VOC controls on the basis of their being highly specialized products with international requirements.

8.2.2 Technical and Economic Feasibility of VOC Limits

Several technical and economic feasibility studies have been undertaken by various countries in support of the passage of VOC limits for automotive refinish coatings over the past decade. A synopsis is given on the main findings of such studies in the subsections below, with emphasis placed on the more recent studies undertaken by CARB, Environment Canada and the EU.

US Environmental Protection Agency (1998)

The US-EPA undertook a technical and economic assessment prior to the promulgation of its national VOC emission standards for automotive refinish coatings in 1998. It concluded that the VOC limits imposed could be met taking into account existing technology.

Cost related to the US-EPA rule were summarized as including: coating manufacturer process modification coats, and costs for training coating manufacturer representatives, distributors and body shop personnel.

The cost of this rule was estimated to be about US$160 per tonne of VOC emission reduction (total cost of $4.5 million 1993 US dollars), thus making the rule an economically efficient means of obtaining VOC emission reductions when compared to the cost of reductions possible through other control measures.

Economic impacts were predicted by the US-EPA to include a maximum price increase of 0.2% or less and a 0.02% increase in the coast of an average repair job. Small business impacts were not expected at that time to be significant.

California Air Resources Board (2005)

CARB (2005) undertook a **technical assessment** of the coating categories for which it proposed automotive refinishing VOC limits. It concluded the following:

- The overall performance of the reformulated products in each category will be similar to the performance of their higher VOC counterparts.

- Except for the adhesion promoter and pre-treatment coating categories, complying products are commonly available and currently being used.

Most of the VOC limits were based on coatings technologies that had been available since 2001. Most of the categories for which VOC limits were promulgated have products that would meet the proposed limits (**Appendix 10**). Only two coating categories, adhesion promoters and pre-treatment coatings, did not have compliant products in the market place as at 2005. CARB (2005) however believed, based on its discussions with paint manufacturers, that all of the VOC limits in its source control measure for automotive coatings are technologically and commercially feasible by the effective date (January 2009).

A technology review approximately one year prior to the implementation date for all the VOC limits was intended to be undertaken, as is standard practice for identifying any unanticipated problems prior to VOC limit implementation.

A summary of conclusions reached in the technical feasibility of specific automotive refinish product types complying with VOC limits, taken from Environment Canada (2006) and including reference to CARB (2005), is given in **Table 36**.

Table 36: Summary of technical analysis of automotive refinish product types in terms with the potential for compliance with VOC limits

Automotive Refinishing Product Ranges	Product Types	Technical Analysis, with reference to CARB (1991), CARB (2005), Environment Canada (2006)
Precoats and Primers	Pre-treatment Coating	A type of "wash" coating, these primers are intended to be applied in one very thin coat on bare metal and are not intended to provide any type of surface build layer. The high solvent level in these coatings provides for a low solids level for the thin film of the wash coat. Limiting the solids content is intended to reduce film build from a pre-treatment coating, thereby reducing the incentive to use a high VOC content material as a primer able to fill large scratches or voids. Water-borne formulations are not used for pre-treatment wash primers since the use of such a formulation directly on bare metal could result in flash rusting. There are no emulsifiable or soluble resins available for water-borne formulations of these primers (CARB, 2005; Environment Canada, 2006). Due to the absence of alternative low VOC technologies, VOC limits for pre-treatment coatings have remained lenient (e.g. CARB limit of 660 g/litre; US limit of 780 g/litre; EC limit of 780 g/litre). CARB (2005) indicated that the VOC limit of 660 g/litre could be achieved by increasing the amount of VOC exempt compounds. CARB was scheduled to conduct a technology assessment in 2008 ahead of the 2009 effective date of its limit.
	Primers / Primer Surfacer	Solvent-based, water-borne and UV-cured coatings are currently available to meet the CARB VOC limit of 250 g/litre and the EC limit of 540 g/litre. Waterborne surfacers have been used in Europe, particularly in the UK, for several years. Use of such products may require longer drying times and hence the use of auxiliary air movement systems, and have the potential for flash rusting on bare metal (Environment Canada, 2006). CARB (1991) evaluated fifteen automotive refinish primers including low-VOC primers. It concluded that there is apparently no correlation between the VOC levels and overall performance of the products evaluated.

Table 36: Summary of technical analysis of automotive refinish product types in terms with the potential for compliance with VOC limits

Automotive Refinishing Product Ranges	Product Types	Technical Analysis, with reference to CARB (1991), CARB (2005), Environment Canada (2006)
Precoats and Primers	Primer Sealer	CARB (1991) compared four sealers including two coatings with VOC levels of below 720 g/litre. The study concluded that VOC compliant sealers were available on the market to meet this limit (limit subsequently revised to 250 g/litre). Primers sealers can require a higher solvent content that primer surfacers to ensure that a relatively thin coating is applied to the surface. It was estimated by Environment Canada (2005) that the typical ratio of primer surfacer to primer sealer use in an average body shop is about 70% surfacer and 30% sealer. Primer sealers able to comply with the CARB limit of 250 g/litre were noted to be available but primarily designed for fleet applications not collision repair. CARB (2005) found that there were differences between the solids contents and type of solids in sealers and surfacers available, and that variations in products were insignificant when comparing between manufacturers. Manufacturers indicated that primer sealers required lower solids content and higher proportion of resins than primer surfacers. A primer sealer compliance with the limit would have less extenders and pigments and more resins than the primer surfacer formulation. Since a higher solvents level is required to dissolve the higher resin content, more exempt solvents would need to be used in place of the primary solvent (Environment Canada, 2006).
Topcoats	Clear Coating	CARB (1991) evaluated a total of eighteen automotive topcoats including products which were VOC compliant to a limit of 720 g/litre. No correlation was found between the VOC levels and overall performance of the products evaluated. The study concluded that (at that time) VOC-compliant automotive topcoats were being marketed by the coatings manufacturing industry in several technologies including single and multiple component, acrylics, urethanes, synthetic enamels and polyesters. Clear coatings available in North America are solvent-borne, with products in existence which meet the CARB VOC limit of 250 g/litre (CARB, 2005; Environment Canada, 2006).

Table 36: Summary of technical analysis of automotive refinish product types in terms with the potential for compliance with VOC limits

Automotive Refinishing Product Ranges	Product Types	Technical Analysis, with reference to CARB (1991), CARB (2005), Environment Canada (2006)
Topcoats	Colour Coating	In 2005, manufacturers indicated to CARB that they intended to use water-borne systems to comply with the VOC limit of 420 g/litre for passenger vehicles. All of the major manufacturing companies have water-borne colour coatings available in Europe to meet the limit of 420 g/litre. Water-borne colour coatings have been used in Europe for about ten years and have been mandated there as of 1 January 2007. Manufacturer's literature for water-borne colour coatings, as reviewed by CARB (2005), indicate that they perform as well as solvent-borne colour coatings when applied properly. Some of the EC compliance water-borne products are currently used in Northern America on a very limited basis (Environment Canada, 2006). The application and curing of water-borne colour and clear coats is different from that of solvent-borne coatings. Additional air flow equipment and heating may be required to cure these coatings and maintain current production levels.
	Single Stage Coating	This represents an older coating technology that is being replaced by colour coating / clear coating systems that use less material and provide a higher gloss with a more durable finish. Single stage coatings are used mostly in production shops where the entire vehicle is painted and a single coating can achieve the desired colour, protection and durability in one application (Environment Canada, 2006). Current single-stage coatings are predominantly solvent-borne, although some water-borne coatings are available.
	Multi-colour Coating	Environment Canada (2006) reports the outcome of its discussions with a manufacturer of products in this category. It indicates that a limited volume of these products is used for automotive refinishing. Furthermore, that the manufacturer's previous attempts at reducing the VOC content of these types of solvent-based products, whilst retaining the required performance characteristics, had been unsuccessful.
Speciality Coatings	Adhesion Promoter	As at 2005, complying products did not exist to meet the CARB limit of 540 g/litre given for this product type. CARB (2005) however anticipated that compliance was possible through increasing the exempt solvent content of coatings.
	Other	Other speciality coatings include temporary protective coatings, truck-deg liner coatings, underbody coatings and uniform finish coatings. Technologies able to meet CARB VOC limits were noted to exist for all of these coating types (CARB, 2005).

CARB evaluated the **economic impacts** of its proposed VOC limits by: (i) contacting coating manufacturers, (ii) comparing the ingredient costs of typical low VOC formulations with higher VOC formulations, and (iii) contacting spray booth equipment and air movement equipment manufacturers. In its assessment of economic impacts CARB took into account:

- Annual costs and cost-effectiveness of its proposed VOC limits
- Economic impacts on Californian Businesses
- Potential impacts on California state or local agencies
- Potential impact on California customers

Potentially affected parties were identified as including any persons that uses, supplies, sells, offers for sale, manufactures, distributes, blends or repackages for sale automotive coatings or associated solvents, or performs automotive finishing. Also, potentially affected are businesses that manufacture air movement or heating equipment for spray booths, or supply resins, exempt solvents or other ingredients and equipment to these manufacturers or marketers. The focus of CARB's analysis was however on coating manufacturers and automotive refinishing facilities given that these businesses would be directly affected by the proposed VOC limits.

The concept of "return-on-owner's equity" (ROE) was used as an indicator of impacts on business profitability. The cost to comply with the proposed limits through increased research and development, equipment purchases, and increased ingredients costs were taken into account.

Key results from the CARB (2005) economic analysis were as follows:

- Total annualized cost to comply with the proposed VOC limits would be about US$14 million.
- The average annual cost to automotive coating manufacturers was estimated to be about US$320,000, resulting in a change in profitability of 0.07%.
- The average annual cost to automotive refinishing facilities was estimated to be about US$3,400, resulting in a change in profitability of 15%. This cost estimate assumes that coating manufacturers pass on all of their costs to the automotive refinishing facilities.
- The estimated change in profitability for automotive refinishing facilities was concluded to be significant if the costs were not passed on to the customer.
- An automotive refinishing facility was estimated to be able to pass their entire cost on to customers by adding US$11 to an average repair cost (estimated to be about US$2,200), thus increasing the repair cost by only 0.5%.
- The cost of the measure was estimated to be US$1,43 per pound of VOC reduced (approximately AUD$4,800 per tonne of VOC reduced). This estimated cost-

effectiveness value was concluded to be within the typical range of costs of existing CARB control measures, which generally fell in the range of no cost to about US6.90 per pound or about AUD$23,000 per tonne VOC reduction.

CARB noted that although most businesses would be able to absorb the costs of the proposed limits without significant adverse impacts on their profitability, there is the possibility that some individual businesses may be adversely affected when the proposed VOC limits are implemented. Businesses that are not in a market position to invest monies to develop new low VOC products, or to absorb the increase costs resulting from their compliance with the proposed VOC limits may be adversely impacted.

Based on its economic analysis, CARB did not expect its proposed VOC limits to have a significant impact on employment, business creation/elimination/expansion, or on the competitiveness of California businesses.

It was recognized that other industries could also be impacted to a lesser amount, which is difficult to quantify (eg. distributors, retailers, 'upstream' suppliers of solvents and other chemicals used in automotive coatings). Distributors and retailers could be impacted because they need to ensure that non-compliant products are not sold after the implementation date. The magnitude of this cost could not be quantified due to lack of data.

Upstream suppliers could be impacted because manufacturers will be purchasing some different solvents and other materials for their reformulated products. It was however not anticipated that these changes would result in a major impact since chemical companies generally supply many different industries, and given that many of the upstream suppliers also provided the alternative products which would be used in the reformulated products. It was expected that some upstream suppliers would benefit due to the demand for new materials to be used in compliant formulations.

Environment Canada (2006, 2008)

A synopsis of the findings from the technical feasibility of specific automotive refinish product types complying with VOC limits, taken from Environment Canada (2006) and including reference to CARB (2005), is given in **Table 36**.

Environment Canada (2006) listed and costed potential capital and recurring cots for both coating manufacturers and users.

Costs to *coating manufacturers* due to the implementation of VOC limits for Automotive Refinishing coatings were given as including:

- Additional colour development for the colour coatings used in Europe, to match with the colours used on vehicles in North America;
- Increasing or developing manufacturing capacity locally for these types of coatings;
- Providing training and support to refinish shops for the transition to these coatings;

- Making adjustments to existing infrastructure for shipping, storage and handling of these coatings; and
- Research and development may be required by some manufacturers to develop water-borne colour coats for passenger vehicles. (Given that manufacturers indicated to CARB that to meet the required VOC limit of 420 g/L for colour coats, water-borne coatings will be used for passenger vehicles, but not fleet vehicles.)

The impact of the proposed Canadian VOC limits on large global automotive refinishing products suppliers was concluded to be negligible. It was noted that these companies had already transitioned to automotive refinishing products with low VOCs to meet regulatory requirements in Europe and the US. Although such companies are currently supplying the Canadian market with automotive refinishing products that have high concentrations of VOCs, such manufacturers indicated that compliant automotive refinishing products are available and can be supplied at no or minimal additional cost.

According to information received by Environment Canada, it was found that some costs could be incurred during transportation and storage of automotive refinishing products by the manufacturers. This incremental cost would be reflected in a higher price of the automotive refinish products paid by the users (ie. repair shops).

Small and medium-size manufacturers in Canada would be impacted by the proposed VOC limits, as some of these industries may need to reformulate their products. Manufacturers in Canada may incur some incremental costs of producing refinishing products separately for domestic and export markets. Manufactures are expected to incur the latter costs in cases where the increased cost of reformulated products negatively affects their competitiveness in international markets. Environment Canada did not quantify these impacts due to lack of data but stated that they are expected to be minor.

It was noted that experience in Europe and in North America has shown that the use of water-borne colour coatings may require changes in shop operations. The changes required will vary according to current set-up of the shop, typical vehicle throughput and the type of airflow in the spray booth. Environment Canada (2006, 2008) listed the following potential capital and recurring costs for *refinish shops*:

- Purchase or upgrading of existing spray booths, or purchase of new spray booths or portable equipment for increased air movement to accelerate drying (or installation of heaters)[(5)];
- Purchase of new spray guns and lines for the water-borne coatings;
- Product training for refinishers;
- Collection and disposal of waste from aqueous streams;

5 Smaller facilities may be able to purchase less expensive air movement equipment and may not need to install heaters due to their having a lower volume of production.

- Efforts or equipment required to reduce dust in ambient air where coatings are applied; and

- Increased requirements for electricity for compressed air and for heating the spray booth, and paint storage area.

The estimated number of collision repair shops in Canada was estimated to be 8,000 of which 72% are small repair shops and the remaining 28% categorized as medium and large. Small operations generally did not have paint mixing machines and only had 1 paint booth, whereas medium to large operations have paint mixing machines and 1-2 or more than 2 (in the case of large operations) spray booths.

It was estimated that all repair shops would incur a 5% increase in the costs for automotive refinishing products in the first five years, following the coming into force of the regulations. During the next 25 years for which the economic analysis was undertaken, the estimated increase in the recurring costs was estimated to be approximately 2.5%.

The estimated cost of the VOC reductions due to the automotive refinish limits was estimated to be in the range of AUD$5,100 and AUD$6,400. These costs were noted by Environment Canada to fall within the benefit per tonne estimated by the US and EU (Ref. **Table 35**).

European Union Studies (2000-2004)

The EC 2004 VOC limits for Automotive Refinishing Coatings were informed by the Entec (2000) study. In its assessment of best available low VOC automotive refinish products and its proposal of limits for consideration and passage by the EC, Entec (2000) noted the following:

- Vehicle finishing products with the lowest VOC content are water-borne coatings. However, water-borne products with appropriate properties are not available for all product categories.

- Water-borne coatings are available for the major functional categories of coating, namely: primer, single layer topcoats, and clear/base topcoats. The performance of such coatings is however questioned by spray shop operators for certain applications. This has resulted in the proposal of compromise VOC limits that permit the use of a number of organic solvent based products.

- No low VOC substitutes are available for etch primers, plastic primers and wet on wet surfacers.

- There are no apparent technical reasons why water-borne products have not been adopted for clear and base coat technology.

- Body stoppers and fillers are high solids organic solvent based materials for which no water-borne substitute is available.

Reference coatings were identified by Entec (2000) for each application, with emphasis on low VOC products that had similar performances as solvent-borne products. Potential VOC emission reductions from automotive refinish coating usage were estimated to be in the range of 19% to 48% if the identified 'reference coatings' were implemented.

The guidance received from the Entec (2000) study, with amendments made during consultative processes, provided a major input for the setting of the EC 2004 VOC limits. In instances where water-borne technologies were not found to be suitable (e.g. wash primers), VOC limits were set higher to allow for the use of solvent-borne technologies.

Entec (2000) estimated the capital and operating cost incurred by small, medium and large body shops due to their switching from solvent-borne to water-borne coatings across the EU. A summary of the findings are given in **Table 37**. Annual costs were estimated to comprise 0.4% of the turnover of small body shops and 0.1% of the turnover of medium to large shops.

Table 37: Estimated Capital and Operational Costs due to Conversion of European Body Shops from Solvent-borne to Water-borne Coatings (Entec, 2000)

Size of Shop	Additional Capex per Body Shop (AUD)	Additional Annual Cost per Body Shop (AUD)
Small body shops	41,000	9,000
Medium body shops	62,000	13,500
Large body shops	145,000	31,500

In assessing impacts on automotive refinish manufacturers, Entec (2000) noted that major paint suppliers tended to be divisions or large global multinational companies. Furthermore, that there is likely to be minimal cost impact on the paint supply companies as the majority of the research and development costs have already been incurred. Companies have already developed water based and high solids coating products and future costs are likely to be for continuous improvement of existing products.

Entec (2000) however indicated that smaller local paint suppliers may struggle to compete if water based coatings become statutory as they may not have suitable products developed.

8.3 Architectural, Wood Care and Industrial Maintenance

Within the Australian coatings manufacturing industry a distinction is made between Architectural coatings, defined as being primarily decorative in nature, and other coatings for buildings and their accessories which do not have decorative purposes (e.g. heavy duty coatings such as structural steel paints).

In Europe, VOC regulations and hence technical and economic assessments are undertaken for general architectural coating types which coincide with Australia's current definition of architectural and decorative coatings (including wood care).

In the US however VOC regulations are jointly promulgated for architectural, traffic marking, industrial maintenance, wood care, and other coatings used for stationary buildings and their accessories, with combined technical and economic feasibility studies undertaken for such coatings. It is for this reason that the Architectural, Wood care and Industrial Maintenance categories are considered together in this section.

8.3.1 Feasibility of VOC Reductions from Local Architectural Coatings

Architectural coatings used in Australia currently are largely (by volume) in compliance with both APAS VOC limits and with EU Phase 1 (2007) limits. This is due to the progressive increase in water-borne coating usage and decline in solvent-borne coatings, with voluntary reductions by industry through the APAS scheme serving to reinforce VOC reductions. Exceedances of APAS and EU 2007 limits do however occur, as is documented in Sections 6.2 and 6.3).

Given EU Phase 2 (2010) Limits, a significant proportion of the products within the following product types would be required to be brought into compliance:

- Metal finishes
- Solvent-based Roof Paints
- Solvent-borne Prepcoats
- Solvent-borne Door, Window, Trim

A large proportion (30% to 70% by volume) of several other product types will also need to have their VOC contents reduced, namely: ceiling paint/flat topcoats, water-based exterior topcoats, water-based interior topcoats, water-based prepcoats.

The technical viability of bringing locally used architectural coatings into compliance with APAS and EU VOC limits was considered with inputs received from major manufacturing industries. A summary of the projected futures, likelihood of VOC reductions required and technical feasibility of realising such reductions is given in **Table 38**.

Certain solvent-borne coatings for specialized applications (eg. stain sealers, penetrating surface binders and metal primers) were identified by industry representatives as critical coating types requiring possible exclusion from product-based VOC controls.

VOC content regulations for aerosol spray packs were perceived by industry representatives as being unjustifiable on the grounds that they comprises only ~1 million litres (3.7 million spray packs), and that cost effective replacement technologies are not available. The reactivity-based VOC regulation of aerosols introduced by CARB was noted.

Table 38: Product future, need for VOC reductions and technical feasibility of reductions projected for Architectural Coating types							
Product Type	Base	Product Type Future	Need for VOC Reductions	Technical Feasibility	VOC Reduction (tonnes/annum) of Compliance with Limits		
					APAS	EU 2007	EU 2010
Prepcoats	SB	Decline	Yes, required to meet APAS and EU limits	Significant VOC reductions not possible. Requires replacement by water-based product (or exemption from reductions?)	101.5	483.2	1366.1
Door,Window,Trim	SB	Decline	Yes, significant reduction needed (on average ~100 g/litre) to meet EU 2010 limits.	Not possible. Requires replacement by water-borne. Market shift is required.		0.1	485.3
Metal finishes	SB	Growth	Yes, to meet EU 2007 and significant reduction (average of over 160 g/litre) required to meet EU 2010 limits.	Technology improvement required to replace solvent volume.		108.9	258
Exterior topcoats	WB	Static	Yes, to meet APAS and EU 2010 limits	Technology exists to meet APAS and EU 2007 limits. Further minor (on average 6 g/litre) VOC reduction needed to meet EU 2010 limits. Three out of five companies require reductions to meet average APAS limits. Likely to be feasible.	131.7	0	193.2
Interior topcoats	WB	Static	Yes, minor reduction to meet APAS and EU 2010 limits	Technology exists to meet APAS and EU limits. Further minor (on average 1 g/litre) VOC reduction needed to meet EU 2010 limits. Only one of five companies marginally exceeds average APAS limits. Reduction appears feasible.	1.3	0	237.4
Ceiling Paint/Flat topcoats	WB	Static	Yes, minor reduction by 1 of 5 companies to meet average APAS limit. Performance adequate to meet EU limits.	Technology exists to meet limits & is largely being implemented. Further VOC reduction is however possible.	7.4	0	38.8
Roof Paint	SB	Decline	Yes, required to meet APAS and EU limits	Significant VOC reductions not possible. Requires replacement by water-based product.	0.1	2.3	24.4
Prepcoats	WB	Static	Yes, required to meet APAS and EU 2010 limits.	VOC reduction possible. Technology improvement required to replace solvent volume.	6.2	0.2	1.1
Paving Paint	WB	Growth	Yes, very minor reduction to meet APAS limits	VOC reduction possible. Technology improvement required to replace solvent volume.	0.5		
"Heavy end" texture	WB	Growth	No. Performance adequate.	Technology exists to meet limits & is being implemented.		0	0
Door,Window,Trim	WB	Growth	No. Performance adequate.	Technology exists to meet limits & is being implemented.		0	0
Fence finishes	WB	Static	No. Performance adequate.	Technology exists to meet limits & is being implemented.		0	0
Roof Paint	WB	Static/Growth	No. Performance adequate.	VOC reduction possible. Technology improvement required to replace solvent volume.		0	0
Paving Paint	SB	Decline	Yes, to meet EU 2010 limits.	Significant VOC reductions not possible. Requires replacement by water-based product.			
Spray packs		Decline		Significant VOC reductions not possible. Requires replacement by water-based product.			

8.3.2 Feasibility of VOC Reductions from Wood care Coatings

VOC reductions achievable by bringing Architectural and Decorative wood care coatings in line with EU limits was primarily as a result of solvent-borne decking paint and to a lesser extent flooring wood care products. Water-based products only comprise 10% of decking paints and 14% of flooring products used in Australia. A significant technology improvement will be required for solvent-borne decking paints to comply with EU limits; potentially replacement by water-borne which requires a market shift. Water-borne technology take-up for in-situ applied floor coatings is reported to be very strong by a large local wood care manufacturer.

In assessing the viability of realising VOC reductions within the *Industrial wood care* sector, the following points are worthy of note (as contributed by Don Dennis, Mirotone, September 2008):

- Purchasers of industrial wood care products are facing strong import competition, particularly for imported furniture that is stained and finished with a clear topcoat.
- Major furniture retailers import furniture directly from abroad and use this lever to extract very low prices that are unprofitable for domestic furniture manufacturers. These manufacturers therefore seek to minimise all cost inputs, including coatings.
- Water-based coatings are more expensive than their solvent-based equivalents and require modifications to the manufacturing process to maintain fast production throughput.
- The customer base of industrial wood care is fragmented, with few customers spending in excess of $500k per annum on coatings.
- The fragmented nature of the Australian wood industry, combined with the small domestic market size makes it difficult for consumers to adopt high volume, automated coating application methods commonly used in Europe, the US and Asia.
- Economical, fast drying coatings with reasonable physical properties able to support fast production throughput is important to consumers.
- Few consumers are set up to apply water-borne coatings currently. Almost none have the infra-red or hot air drying capabilities required to dry waterborne coatings in winter and in humid conditions. Most consumers would not have the available capital or production volumes to make the required investment and still remain economically viable.
- In terms of transitioning to lower VOC technologies, there is an increasing interest in water-based technology for certain coating ranges (e.g. in situ applied flooring products). The easiest transition for most consumers would however be to higher solids coatings since the application technique remains the same and no capital investment is required.

- Market segments within industrial wood coatings that are currently dominated by water-based technology, are primarily characterised by high volume flat panel production on roller coating lines.

Wood care product manufacturer Mirotone's approach has been to increase application solids where possible and reduce the MIR value of the solvent blends used. This latter approach has primarily been achieved through reducing the usage of aromatic hydrocarbons. The rational given for this is that it is generally significantly easier to change a solvent blend without reducing total VOC content (and achieve a substantial reduction in MIR value) that it is to reduce total VOC content. It is for this reason that Mirotone representatives have lobbied for the consideration of a reactivity-based rather than total VOC mass-based approach to VOC regulation. Examples of formulation innovations for wood care products developed to reduce the reactivity-weighted VOC emission potentials are given in **Appendix 5**.

8.3.3 International Technical and Economic Feasibility Studies

Several technical and economic feasibility studies have been undertaken by various countries in support of the passage of VOC limits for architectural, industrial maintenance and other coatings over the past decade. A synopsis is given on the main findings of such studies in the subsections below, with emphasis placed on the more recent studies undertaken by CARB, Environment Canada and the EU.

CARB (2007)

CARB approved a Source Control Measure (SCM) for Architectural Coatings in 2000 which includes VOC limits that are recommended for use by several districts in California. In 2007 CARB proposed to update this SCM by removing 15 of the previous 47 categories, adding ten other categories and lowering the VOC limits for 19 categories. The new limits would come into effect at the beginning of 2010.

The detailed technology assessment was undertaken by CARB for all coating categories included in the 2007 SCM is documented in CARB's *Technical Support Document for Proposed Amendments to the Suggested Control Measure for Architectural Coatings* (September 2007). Reference should be made to this document for a detailed discussion of the findings.

One interesting development is that CARB has introduced a more general category called "Wood Coatings" to include clear and semi-transparent coatings, namely: lacquers, varnishes, sanding sealers, penetrating oils, clear stains, wood conditioners used as undercoats, and woos sealers used as topcoats. The Wood Coating category also includes opaque wood coatings: opaque lacquers, opaque sanding sealers and opaque lacquer undercoats. Whereas in CARB SCM 2000 VOC limits for wood care products ranged from 250 to 680 g/litre, the proposed VOC limit is given as 275 g/litre. (To comply with such a stringent limit a significant portion of Australian wood care products would need reformulation or replacement.)

Based on CARB's technology assessment of all coating categories, it concluded that the overall performance of the currently complying and reformulated products in each category is similar to the performance of their higher VOC counterparts. To confirm this analysis, CARB will conduct technology reviews for the proposed VOC limits that are lower than current limits prior to their effective dates. Notably, these assessments will be conducted for the following categories:

Aluminium roof
Bituminous roof
Concrete/masonry sealer
Driveway sealer
Dry fog
Flat
Floor
Mastic texture
Non-flat
Non-flat – high gloss
Primers, sealers and undercoats
Reactive penetrating sealer
Roof
Rust preventative
Speciality PSU
Traffic marking
Waterproofing membrane
Wood coatings
Zinc rich primer

Certain of the 2007 CARB SCM limits are considered to be 'technology forcing' by industry representatives, ie. In some cases innovative and new technology may be required to achieve the required limits. This may be considered suitable in the special context of California where extreme smog episodes and high associated health and environmental costs are experienced.

Following its economic assessment, CARB (2007) concluded that the cost-effectiveness of individual product limits would range from a net saving to a net cost of US$13.90 per pound of VOC. The greatest cost was associated with Floor Coatings. The complying market share for Floor Coatings was calculated to be 85%, with many manufacturers having already reformulated their coatings to meet the proposed VOC limit. CARB therefore believed that it is appropriate for the remaining manufacturers to reformulate their products to meet the proposed limit.

The overall average cost-effectiveness of the proposed limits was estimated to be US$1.12 per pound of VOC reduced (ie. about AUD$3,700 per tonne VOC). This was viewed as comparing favourably with the cost-effectiveness of similar regulations.

Profitability impacts on paint manufacturers were estimated to be a decline in profitability of 2.1% (ranging from 4.7% for small manufacturers to 1.1% for large manufacturers). This impact was not considered to be a significant impact on the profitability of affected businesses.

Companies supplying resins, solvents and other chemical and equipment for use in reformulation of architectural coatings were identified as potentially benefiting, while companies supplying raw material for non-compliant coatings may experience a decline in demand for their products.

CARB's analysis indicated that most affected businesses would be able to absorb the cost of the proposed SCM with no significant adverse impacts on their profitability. However, it was noted that the proposed SCM may impose economic hardship on some businesses with small or no margin of profitability.

If all costs were passed onto the customer, CARB estimated an average potential increase in the cost of coatings of about 6%.

Environment Canada (2008)

In the setting of the proposed Canadian VOC limits for architectural, high-performance industrial maintenance and traffic marking coatings reference was primarily made to the CARB 2000 SCM and to the revised 2007 US-EPA limits. No detailed technical assessment was undertaken, with use primarily made of the work undertaken by CARB in this regard.

The impacts on industry were anticipated to manifest themselves primarily in the operations of coating manufacturers. Other impacts on industry include those on resin and solvent suppliers and those on commercial coating users (painting contractors, etc.).

Upstream, the net impact on resin and solvent suppliers was estimated to be small, given that the overall quantity of manufactured coatings would not differ significantly from the baseline. Resin suppliers are expected to experience a net gain in revenues, as the demand for more expensive, low-VOC resins increases. Solvent suppliers are expected to experience an overall decline in demand for their products, as architectural coating formulators increasingly switch their production to water-based technology (Environment Canada, 2008).

Downstream, commercial end-users of architectural coatings, including commercial painting contractors, are expected to face limited cost increases, to the extent that there are incremental increases in coating process or modification to the application equipment. It was held that this increased cost may be offset by reduced costs of thinning and cleaning products and safety equipment. It was expected that commercial painters would be able to pass some of the cost increases on to their customers.

For manufacturers, the incremental cost of meeting the VOC limits was given by Environment Canada (2008) as comprising the following elements:

- One-time cost to reformulate coatings to meet the VOC limits;
- One-time new substance notification costs for new substances in low-VOC coating formulations;
- One-time cost to meet the proposed labelling requirements;
- One-time costs including capital expenditures for new/upgraded storage facilities necessary for water-based coatings;
- Annual, recurring administration cost; and
- Annual, recurring raw materials cost.

Environment Canada estimated costs to be less than 4% of industry revenue while firms absorb the one-time costs of compliance, and about 2% of revenue thereafter. It was anticipated that if manufacturers were unable to pass the increased cost on to consumers, the resulting reduction in profitability may result in employment reductions and/or increased competitive pressures in the market.

The estimated cost-effectiveness of the proposed Canadian VOC limits is estimated to be in the range of AUD$1,200 to AUD$1,600 per tonne of VOC reduction.

European Union Studies (2000-2004)

In its *Proposal for a Directive of the European Parliament and of the Council on the limitation of emissions of VOCs due to the use of organic solvents in decorative paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC* (2003), the EU Council highlighted findings from supporting studies. The most notable of such studies, dealing with architectural coatings, are the Decopaints Study (2000) and the economic analysis conducted by the Air and Noise Unit (2002).

The Decopaints Study (2000) comprises a detailed technical assessment of the viability of low-VOC technologies for architectural and decorative applications. The findings of this study are dated but still valid, and the reader is directed to the Decopaints report for details of the technology assessment which underpinned the EU 2004 VOC limits.

The main conclusions of the economic analysis for the then proposed EC VOC limits (Air and Noise Unit, 2002) were as follows:

- Individual cost increases due to the abatement of VOCs in specific coating categories were given as follows:

Product Sub-category	**Technology Conversion**	**Average Cost of Reduction per tonne of VOC reduced (Cost given in AUD based on projected cost in Euros given for 2010)**
Interior matt and glossy walls and ceilings	WB to WB	100
	SB to WB	2,500
Exterior walls of mineral substrate	WB to WB	100 - 1,500
	SB to SB	100 - 1,500
Interior/exterior trim and cladding paints for wood and metal	WB to WB	100 - 1,500
	SB to SB	100 - 1,500
Interior/exterior trim varnishes and wood stains	WB to WB	100
	SB to SB	100
Primers and binding primers	WB to WB	1,500
	SB to SB	100
One pack performance coatings	WB to WB	100
	SB to SB	100
Two pack reactive performance coatings for specific end use such as floors	WB to WB	1,500
	SB to SB	100
Multi-coloured and decorative effect coatings	WB to WB	1,500
	SB to SB	1,500

- The overall annual reduction in VOC emissions due to the VOC limits, estimated to be about 280 kilo tonnes in 2010 (~95% due to decorative paint and varnish and 5% from automotive refinish coatings), would cost between AUD$770 and AUD$1,100 per tonne of VOC reduced. The range in cost estimates was given as being due to uncertainties about additional costs for exterior paints.

- Benefits due to VOC reduction were quantified as being about AUD$4,100 per tonne of VOC reduced (best estimate), thus being estimated to be four to five times higher than costs.

- The benefits of reducing VOC emissions outweighed the cost, even without including avoided damage to ecosystems.

On the basis of the Decopaint (2000) and Air and Noise (2002) studies, the EU (2003) concluded the following:

- On the basis of established trends in these sectors in favour of products with lower solvent content, it would be technically and economically possible to reduce VOC content further within a realistic timeframe and without compromising product quality.

- The emission reduction costs of measures proposed were well within the range of the costs of the VOC emission reduction measures envisaged for all Member States.

- VOC emission could be reduced by approximately 260 kilo tonnes by 2010 by reducing the solvent content of decorative paint and varnish products, and by about 15 kilo tonnes by reducing the solvent content of vehicle refinishing products.

- Some uncertainties in the technical feasibility and economic viability of significant improvement in certain product categories were noted and resulted in maximum content limits being set for these categories.

- It was noted that less potential existed for reducing the solvent content in other product groups at that stage.

8.4 Protective and Marine Coatings

Detailed technical and economic studies could not specifically be found for the Protective and Marine Coatings (PMC) sector. Key factors affecting the potential regulation of VOCs from this sector are however noted to include the following:

- The PMC market is primarily supplied by global paint companies that have major product platforms that have been formulated to meet future EU or current US regulation.

- Performance specifications and user requirements are global in nature, particularly for commercial marine coatings.

- Underwater systems have performance testing and regulatory requirements that preclude rapid product changes.

- Yacht and pleasure craft coatings are mainly applied at professional applicator facilities and by DIY owners. The technology for such coatings however derives in part from Commercial Marine and is therefore often global in nature.
- Low VOC PMC products are frequently more expensive technologies.
- Due to the significant performance required for PMC coatings, it is considered critical that life cycle assessments be undertaken to determine the viability of realising overall VOC emission reductions whilst maintaining the performance of coatings.
- The Californian (proposed Hong Kong) VOC limits given for PMC coatings are perceived by industry representatives as being very restrictive. It is claimed that the CARB VOC limits have resulted in the Pleasure Craft industry being forced to move out of California and operate from neighbouring states.
- Additional coatings categories are scheduled to be introduced within the Marine and Pleasure Craft coating categories as a result of international developments. The International Maritime Organisation (IMO) International Convention on the Control of harmful Anti-fouling Systems on Ships, which came into force 17 September 2008, has a requirement for additional speciality coating categories aimed at actively sealing banned anti-foulings under the convention.

8.5 Costs Associated with Compliance Promotion and Enforcement

The regulation of the VOC content of surface coatings will give rise to cost to government in respect of compliance promotion and enforcement.

Compliance promotion activities could include mail out of the final regulations, development and distribution of promotional materials (eg. Fact sheets, Web material), advertising in trade and associated magazines, attending trade association conferences, and presenting workshops and information sessions to explain the regulations. It may also include responding and tracking to inquiries.

Enforcement activities typically include the delivery of training, inspections, investigations, and implementation of measures to deal with alleged violations.

8.6 Conclusions

Regulatory impact assessments, including technical and economic feasibility studies were completed prior to the introduction of product-based VOC limits for surface coatings within the US, Canada and the EU.

In many cases, lower VOC technologies with similar overall performances compared to the performance of the higher VOC counterparts, were identified and the setting of tighter VOC limits supported.

In cases where the availability of low VOC technologies with acceptable performances was uncertain, two courses of action were generally followed:

- VOC limits were set higher to enable the use of higher VOC technologies (e.g. solvent-borne wash primers in case of EU and US); potentially to be made more stringent in future as lower VOC technologies evolve.
- Stringent (technology forcing) VOC limits were set, with a commitment to conduct technology reviews prior to the effective dates of such limits. This approach is adopted by CARB.

Overall findings of economic studies commissioned by the US-EPA, CARB, Environment Canada and the EU in support of Architectural and Automotive Refinish Coating VOC limits are as follows:

- The cost to coating manufacturers was generally concluded to be relatively low. It was however noted that certain manufacturers (specifically local and/or small to medium sized manufacturers) may be more significantly impacted.
- The cost to primary coating users was concluded to be varied. In the case of automotive refinish shops, costs were identified as being significantly high if costs could not be passed on to customers.
- The overall average cost-effectiveness of proposed VOC limits were within the range considered acceptable, i.e. compare favourably with the cost-effectiveness of similar regulations.
- The benefits of reducing VOC emissions outweighed the environmental cost, when externalities such as health savings were accounted for.

Caution must be used in interpreting the findings of international economic studies for the following main reasons:

- Study findings reflect the specific economic contexts (markets, timeframes) within which the studies were conducted and are not directly transferable to the Australian case. Such findings are useful in assisting in the identification of potentially affected parties and in providing a first approximation of the relative impacts on such parties.
- The cost efficiency of measures are expressed in terms of overall costs (dollars) per tonne of VOC reduced, with costs reflecting expenses incurred due to measure implementation less the savings (benefits) realised by the VOC reduction. Expenses and savings mainly accrue to different parties, with the overall cost per unit VOC reduction not reflecting actual costs to the surface coating industry.
- The quantification of impacts was typically limited to impacts on coating manufacturers, primary end users and consumers, with impacts on other parties (eg. upstream and downstream industries) being only qualitatively assessed.

- Given the recent economic downturn, several representatives from the Australian surface coating industry emphasised that any reduction in company profitability, however limited, would be viewed in a serious light.

Based on the review of international assessments and knowledge of the Australian market, the following parties identified as being possible at greatest risks due to the introduction of product-based VOC regulations for Automotive Refinishing:

- Small and medium-sized manufacturers in Australia which may need to reformulate their products, and/or which may need to produce refinishing products separately for domestic and export markets.

- End-users, specifically smash repairers. Automotive refinishing industry representatives estimated that 60% to 70% of the approximately 4,500 smash repairers operating nationally may be negatively impacted by introduction of product-based VOC controls in the short term (assuming costs are not passed on to customers).

- Global paint companies operating locally may be negatively impacted if Australian-specific regulations resulted in US and/or EU compliant products being excluded.

Parties potentially impacted by VOC reductions for Architectural and Decorative Coatings were identified as including:

- Paint manufacturers, with the potential for impacts on the profitability of such companies.

- Coating consumers, including private and professional users.

- Up- and down-stream companies. Companies supplying resins, solvents and other chemical and equipment for use in reformulation of architectural coatings were identified as potentially benefiting, while companies supplying raw material for non-compliant coatings may experience a decline in demand for their products.

9 Regulatory Considerations

Factors to be taken into account during the regulatory process are outlined in this section, in the event that projected VOC emissions and Ozone Formation potentials are deemed substantial enough to warrant the consideration of VOC regulations for surface coatings.

9.1 Potential Coating Categories to be Targeted

In identifying coating categories to be targeted by potential regulations, it is pertinent to consider:

- Product categories which are primarily not used in controlled environments (or environments able to be controlled effective).

- Product categories which contribute significantly to potential VOC emissions and ozone formation potentials, as a result of the uncontrolled environments in which they are used, the volumes used, their VOC content and/or the high reactivities of the solvents used (Ref. **Section 5**).

- Product categories typically regulated by other countries (Ref. **Section 6**).

In the US, product-based VOC regulations are issued for Architectural (which includes industrial maintenance, traffic marking and architectural wood care coatings), Automotive Refinishing and Aerosol spray paints. The US-EPA however issues Control Technique Guidelines (CTGs) in lieu of federal regulations if it can be determined that a CTG would be substantially as effective as a rule in reducing VOC emissions in ozone non-attainment areas.

CTGs are issued for the following coating categories: Aerospace, Shipbuilding and Repair, Wood Furniture, Flat Wood Panelling, Lithographic Printing Materials, Letterpress Printing Materials, Large Appliance Coatings, Miscellaneous Metal Products coatings, Plastic Parts coatings, and Auto and Light Duty Truck OEM Coatings.

For some coating users, a multi-pronged approach to VOC control is implemented which includes product-based VOC controls in addition to source-based measures. A case in point is the US-EPA's control of VOC emissions from body shops. Despite VOC concentration limits for automotive refinish products having been promulgated in 1998, the US-EPA has various programs aimed at promoting best practice source controls within the auto refinish industry to reduce VOC emissions in addition to toxic emission of diisocyanates, organic solvents, heavy metals and other hazardous air pollutants (eg. the Collision Repair Compliance Assistance Program).

Given the aforementioned considerations the following Product Categories could be considered for initial attention:

Market Segment	**Product Category:**	**% of Total Volume of Product**	**% of Estimated VOC Emissions**	**% of Estimated Ozone Formation Potentials (OFP)**	**VOC Control Achievable in Short- to Medium Terms**
Architectural & Decorative	Arch & Dec Paints & Enamels	70	25	22	5% to 30%
	Arch & Dec Wood care	3	8	8	25% to 40%
Automotive	Automotive Refinishing	5	17	19	total VOCs, 10% to 60%(a) Ozone formation, >40%
Industrial	Road & Runway Marking	2	1	1	
Total		**81%**	**52%**	**50%**	

(a) The range for total VOCs reflects differences in the technologies which may be adopted within the regulatory framework selected. If the US approach is followed, where provision is made for exempt solvents, total VOCs would be reduced in the range of 10% to 30%. Given the EU approach of controlling total VOCs, total VOCs would be reduced by 45% to 50%. Based on the literature and information provided by a local large-scale automotive refinish paint manufacturer, it was noted that VOC emission reductions from actual smash repair operations using low VOC technologies are likely to be in the range of 60%.

The Architectural and Decorative segment (including paints, enamels, wood care) accounts for almost 75% of coating volumes used in potentially uncontrolled environments, and about 30% of the resultant VOCs and OFP. Conservatively, it is estimated that the VOCs/OFP could be reduced by 10% to 30% in the short- to medium-term (3-5 years), through the implementation of best practice product-based VOC concentration limits. The control of VOCs within this segment could also result in further VOC reductions due to possible decreases in the quantity of Architectural & Decorative thinners used. (Architectural thinners accounts for a further 7% of total VOCs.)

VOC and OFP reductions to be achieved in the Automotive Refinishing Category are dependent on the regulatory approach to be adopted, with reductions of as high as 60% possible. The use of low VOC technologies has also been shown to result in reductions in VOC emissions from other smash repair operations (eg. gun washing) by 50% to 60%.

Despite the small contribution of road and runway marking coatings, these coatings are frequently regulated due to their being used in uncontrolled environments and frequently as part of government commissioned work.

Further Coating Categories which could be considered for control are:

Market Segment	Product Category:	% of Total Volume of Product	% of Estimated VOC Emissions	% of Estimated Ozone Formation Potentials (OFP)	VOC Control Achievable in Short-to Medium Terms
Industrial	Other Industrial - Finishing Coats	3	8	12	Undetermined
	Other Industrial - Primers & Undercoats	5	6	6	Undetermined
	Industrial Wood care	2	7	8	Undetermined
Heavy Duty	Protective Coatings	5	8	9	Undetermined
Total		**15%**	**29%**	**34%**	

Although EU VOC limits do not extend to industrial and heavy duty coatings, some products within these segments are regulated in the US and proposed for regulation in Canada.

Architectural coatings regulated in the US include so-called Architectural and Industrial Maintenance (AIM) coatings. According to US regulations, an architectural coatings is a coating recommended by the manufacturer for field application to the surface of a stationary structure, portable building, pavement, or curb to protect, decorate, or serve some other function. Architectural coatings include many categories such as interior and exterior paints, traffic markings, sign paints, as well as industrial maintenance coatings. Architectural coatings do not include coatings recommended by the manufacturer or importer solely for application in a factory or shop as part of a manufacturing process. Nor do they include coatings recommended solely for application to non-stationary structures such as airplanes, ships, boats and railcars.

Information on industrial and heavy duty coatings used in Australia was only available for production types rather than by end use types. This made it impossible to determine, with any certainty, which coating product types or proportion of such types are being used within factory applications. Due to this limitation and the lack of detailed information on the 'ready for use' product compositions (excluding water), compliance with US/CARB VOC limits could not be determined. The potential for VOC reductions could therefore not be determined.

If VOC concentration limits are to be set for industrial and protective coatings it is recommended that:

- Products specifically designed for end uses such as aerospace, flat board, can and coil, large appliance coatings (etc.) be exempt. These coating products are used primarily in large industrial facilities where emissions are being, or could be, regulated under license and VOC abatement measures required.

- Life cycle analysis should be undertaken prior to the requirement that low VOC technologies replace high performance coatings used in specialised protective applications.

Reasons given by Marine and Yacht Coatings industry representatives for not considered this segment for product-based VOC regulation included:

- small volumes and small contribution to VOCs
- market being primarily supplied by global companies with products manufactured under EU or US regulation
- international user specifications to be met
- highly specialized products

Marine coating applications in Australia are smaller-scale and less centralized than those abroad with the potential for successful source-based controls uncertain. The study however confirmed that Marine and Yacht coatings together accounted for only 1% of coating volumes assessed, and 2% of the VOC and ozone formation potentials. Preliminary analysis also indicated that limited VOC reductions could be achieved from these coating categories.

9.2 Alternatives to Regulation

Alternatives to the implementation of product-based VOC regulations include: maintaining the status quo, additional voluntary action and implementation of market-based instruments.

The feasibility of voluntary measures and market-based instruments such emission trading programs, fees and charges and tax incentives and disincentives were briefly considered based on the review of such instruments by other countries. Countries in North America, Europe and parts of Asia consider product-based VOC regulation the most effective method of achieving VOC reductions from the use of architectural, automotive refinishing and in certain cases industrial maintenance coatings, when compared to source-based controls, voluntary measures and market instruments.

Internationally, the view exists that further reductions are technologically and economically achievable than are realised through voluntary reductions due to there being insufficient incentive for manufacturers and importers to widely develop and market low-VOC coatings. Voluntary arrangements are also not perceived to guarantee reductions in VOC emissions from many sectors, as is required to meet the objectives of governments.

Furthermore, voluntary measures may yield an unfair advantage to those companies that choose not to participate in the initiatives and continue to market their products without having to put resources towards the research and development necessary to create coatings with lower VOC concentrations.

Market-based instruments include emission trading programs, fees and charges and tax incentives and disincentives. Such instruments work by encouraging changes in consumer and producer behaviour, and when successfully designed and implemented can promote cost-effective action and provide long-term incentives for pollution reduction and technological innovation.

An emission trading system was considered by the Canadian government as a means of managing VOC emission from architectural coatings. It was however concluded that such a system would not function at the point of use since there are a large number of widely dispersed users. Furthermore, there would be significant issues concerning the measurement and verification of emission reductions. Although a trading system could be envisaged at the manufacturer level, it is unlikely that such a system would be efficient or effective. It would require setting a cap on the quantity of VOCs used for each of the facilities manufacturing coatings, with a mechanism needed to ensure other that VOC reductions from coatings covered under other measures were not included in the cap. This complexity would increase the administrative costs of the mechanism substantially (Environment Canada, 2008).

Fees and charges could be levied on products containing VOCs above the proposed concentrations. It is however expected that such a system would require a significant amount of time to implement and, as technology evolves, would require changes in fee structure to achieve additional cost-effective reductions.

In terms of the status quo within Australia, various architectural and certain industrial maintenance coatings are limited under the voluntary APAS scheme. This scheme has historically achieved notable success, serving to encourage significant VOC reductions within the architectural sector but also requiring that such reductions not undermine the technical performances of coatings.

A limitation of APAS is that VOC limits selected are primarily decided on by industry representatives. The setting of increasingly stringent VOC limits for architectural coatings was supported by market changes, with water-borne coatings becoming increasingly more prevalent within this segment. The ability of APAS to set more stringent limits, where such limits would require product reformulations or technology changes not necessitated by market forces, has been questioned.

Furthermore, the APAS scheme does not extend to other coating categories such as automotive refinishing. The APAS executive has started collecting information on automotive refinish coatings, with the view to the potential inclusion of such coatings in the scheme. Automotive refinishing manufacturing industry representatives consider it highly unlikely that this sector could be successful controlled under the scheme due to the nature of the market. It is held that regulation would be required to force significant technology shifts in the sector.

With regard to market-based instruments, Australian coating manufacture representatives requested that tax incentives or other financial benefits be considered for paint manufacturers and others as a means of covering some of the costs associated with moving to lower VOC technologies.

9.3 Overarching Considerations and Issues

9.3.1 Regulatory Barriers

The importance of minimise bureaucracy within the regulatory compliance process has been frequently raised in discussions with industry representatives.

Most notable is the hurdle posed by the National industrial Chemicals Notification and Assessment Scheme (NICNAS) process, and the impact of this process in terms of delaying product reformulations.

The NICNAS process was consistently raised as the major regulatory and overall impediment to the timely and cost-effective achievement of significant VOC reductions.

9.3.2 Global Market Considerations

The importance of harmonization with other countries was emphasised by certain Australian paint industries active in global markets, notably industries within the Automotive Refinishing, Protective Coating, Marine and Yacht markets. Such industries favoured the adoption of EU or US VOC limits rather than the exclusive stipulation of locally-derived regulations, or for US and/or EU compliant products to be allowed to be used locally in addition to products compliant with local regulations.

Benefits of global harmonization were given as including:

- More speedy adoption of existing low VOC coatings technologies used abroad;
- Ready access to overseas advances in low VOC technologies; and
- Export of locally developed low VOC coatings to EU and US.

Architectural and Decorative products used locally are however mostly manufactured locally, and tailored to suit local circumstances and environments. Requirements for such products are frequently different from those abroad in terms of performance and application, with less emphasis therefore placed on the need for global harmonization. Manufacturers of Architectural and Decorative coatings held the view that Australia should not simply adopt a VOC regulatory scheme from abroad, although elements of those schemes may be incorporated into locally developed regulation.

9.3.3 Additional Information Required to Inform Regulations

For product types for which the technical viability of switching to lower VOC technologies is uncertain it is recommended that a detailed technology review be undertaken to inform the regulatory discussions. Such a review would need to consider:

- Access to low VOC technology & products
- Regulatory obstacles to introduction of new technologies (NICNAS)

- Phase-in timeframes needed for introduction of new technology
- Pack size limitations (if applicable)

In addition to the regulatory impact assessment undertaken by CARB in support of its Architectural and Automotive Refinishing SCMs, CARB commits to conducting technology reviews approximately one year prior to the implementation date of VOC limits. This is considered to be standard practice for identifying any unanticipated problems prior to VOC limit implementation.

In the case of specialised products where shifts to lower VOC technologies could adversely impact product the technical performance of the product (e.g. durability, reduced protection against corrosion), the implementation of life cycle analysis should be considered.

Cost-benefit analysis should be done for potentially affected segments as part of the regulatory impact assessment process. Based on preliminary observations, such CBA may be necessary for the local manufacturers and local users of automotive refinishing products by example. Costs to be taken into account should include: cost from product substitution (including upstream and downstream costs), loss of market share to imports and loss of export markets.

9.3.4 Other Issues

Other issues specifically raised by industry representatives in respect of potential product-based VOC regulation were as follows:

- Regulation, if introduced, should cover usage, whether locally manufactured or imported to ensure a level playing field.
- Australia should consider moving in parallel with New Zealand.

9.4 Approach to VOC Regulation

There are various options for the structuring of potential product-based VOC regulation for the coating sector. Such options include:

- *Mass-balance approach targeting Total VOCs.* This approach, implemented by the EU, comprises all VOCs being treated in the same manner, with regulation by total weight of solvent in paint. This approach is implemented by the EU.
- *Mass-balance approach, targeting VOCs excluding exempt solvents.* This approach comprises the exclusion of certain solvents from total VOC calculations on the basis of their not contributing to tropospheric ozone formation. All non-exempt solvents are treated equally on the basis of their total weight. In the exemption of solvents, care is needed to ensure that such solvents are not hazardous to other aspects of the environment, eg. toxic, stratospheric ozone depleting, greenhouse gas. This approach is implemented in the US, Canada and Hong Kong.

- *Reactivity-based VOC regulation*, comprising the integration of “Carter Holt Reactivities” or other such scales into regulations to regulate VOC content in proportion to the ozone reactivity of the solvents in the paint. This necessitates the determination of the grams of each solvent, multiplying by reactivity factor for that solvent and then sum across all solvents to give the total g of O_3 generated by 1 litre of paint. This approach is implemented in the US for aerosol coatings.

- *Acceptance of EU and/or US compliant products*, with potential addition of new Australian limits for products not falling under the EU/US regulatory regimes.

- *Combining of two or more of the above approaches*. For example: Adoption of mass-based VOC limits (either as total VOCs, or with exemptions), but including a flexibility option based on reactivity.

  In the US in 2007, the National Paint and Coatings Association (NPCA) suggested an Innovative Product Exemption (IPE) for reactivity be included in CARB’s SCM for Architectural Coatings. Under the NPCA proposal, coating manufacturers could sell products that exceeded mass-based VOC limits, if the product has a lower reactivity than a representative product that complied with the mass-based VOC limit. Although concerns were expressed regarding the resources required to enforce such a reactivity-based IPE provision and that such a provision has not yet been adopted, it is notable that CARB continues to investigate its use.

The advantages and disadvantages of the various approaches were discussed with coating manufacturing industry representatives during the study, primarily with the purpose of identifying related technical, economic and other issues. A summary of the main views expressed by industry representatives within the various market segments is given in the following subsections.

9.4.1 Industrial Coating Manufacturer Views

In terms of the nature of potential VOC regulations, if such regulations were to be implemented, Industrial Coatings segment representatives favoured:

- Acceptance of EU and US (CARB) compliant products on the basis of: export markets; ready access to low VOC coating technologies developed abroad; economies of scale) without additional tests of such products being required;

- in addition to Australian regulations for locally-manufactured products.

With regard to the integration of VOC-based reactivity considerations into potential Australian regulations, the Industrial Coatings representatives consulted held the following (conflicting) views:

- Inclusion of reactivity is necessary to ensure that the objective of reduced tropospheric ozone formation is able to be met through implementation of the limits.

- Adoption of a total VOC approach to limits could impact unnecessarily on product types which have high total VOC contents but low overall reactivity-weighted VOC contents.

- Reactivity is too complex to incorporate since it requires the selection and application of reactivity factors for individual solvents within products, and products may comprise a number of different formulations for end use. Detailed information on solvent use per final product would need to be kept to meet information requirements.

9.4.2 Automotive Coating Manufacturer Views

It is notable that automotive refinishing coating manufacturers perceived the absence of VOC regulations as being responsible for the low take up of low VOC products. VOC regulations were considered to be necessary to secure the use of automotive refinish products, due in part to the control insurance companies exerted on the pricing of body shop operations.

If VOC regulations were to be implemented, the following points were noted by the Automotive Coatings focus group:

- The Automotive Refinish market is primarily supplied by global paint companies with major product platforms formulated to meet EU or US regulation. For this reason it was advocated that any regulations in Australia should allow the use of products compliant with EU or US VOC regulations. The stipulation of Australia-specific definitions and limits only would restrict access to global, low VOC technologies.

- The group generally advocated acceptance of EU and US (CARB) compliant products and acceptance of locally-manufactured products designed to be EU or US compliant.

- EU was given as being preferred and CARB as acceptable by representatives from the major paints companies in attendance. Exclusion of US compliant products could however impact negatively on local manufacturers of automotive refinish products who produce for both local and US markets.

- Nature of EU regulations for automotive refining were observed by some to be more simple and more effective at reducing total VOCs due to the absence of exemptions.

- EU regulations were considered by some to drive the use of solids and oxygenated solvents.

- US regulations were considered by some representatives to result in reformulations using more polluting hydrocarbons.

- Representatives of the major paint companies indicated that their companies would favour moving to water-borne technology even if both EU and US compliant products were to be accepted.

9.4.3 Architectural and Decorative Coating Manufacturer Views

If VOC regulations were to be implemented, the following points were noted by Architectural and Decorative Coating manufacturer representatives:

- Australia-specific regulations were preferred, potentially incorporating elements of other schemes. Australia should not 'pick up' a VOC regulatory scheme from another country but may incorporate certain elements from those schemes. The EU approach was generally preferred above the US and CARB approaches.

  - Aspects of the EU approach which were favoured:

    - Total VOC approach without exemptions. (US approach seen as 'farcical' due to the exemption of solvents said to give rise to other potential environmental problems. The EU approach was perceived as giving rise to more significant reductions in total VOC emissions and therefore less risky environmentally.

    - VOC calculations (and limits) applied to already diluted (ready for use) products. There was support for the EU approach which uses total liquids (including water) in the formula for calculating VOC concentrations. (The US approach excludes water and exempt solvents from VOC calculations.)

  - Aspects of the EU approach which were not supported:

    - Labelling of products. The Architectural Group did not favour the need for labelling of products as part of a VOC regulation (e.g. European approach which requires that the VOC limit and VOC content be placed on products). The Group preferred that products just meet the necessary criteria, with voluntary labelling if manufacturers wanted to advertise better then required performance.

    - Stringency of EU 2010 VOC limits aimed at rapidly phasing out solvent-based products. It was noted that due to solvent-based products not historically having been declining 'naturally' in use, Europe took the decision to 'force out' these products by introducing stringent VOC limits, thus necessitating and accelerating the adoption of water-borne products. It was argued that in Australia there has been a definite and ongoing progression away from solvent-borne and towards water-borne products, and that this trend be recognized and documented.

- On the issue of potential acceptance of EU and US compliant products as part of a possible Australian VOC regulation scheme, the following was noted:

  - Architectural and decorative products used locally are mostly manufactured locally (unlike automotive refinishing for example), and tailored to suit local circumstances and environments. Requirements of such products are frequently different from abroad in terms of performance and application.

There was therefore less interest in the need for harmonization in this respect from this group.

- o Although use of EU and US compliant products could be allowed, checks and balances should be put in place to ensure that products imported and claiming to be compliant with such regulations are in fact complaint. Such checks and balances should not be in the form of requirements of testing of all imports but rather just spot checking and checking when breaches are suspected (as the government currently does for other products).

- Incorporation of a reactivity-based approach to VOC regulation was seen as being too complex to be the mainstream approach. There was however no opposition to a reactivity-based VOC exemption clause being included, with manufacturers given the option of choosing to do the additional work required to demonstrate compliance with this limit so as to be exempted from the Total VOC limit.

Potential e*xemptions* for low toxicity, low reactivity solvents was discussed by the Architectural and Decorative focus group, specifically with regard to the reactivity of propylene glycol, the major solvent used in water-borne products. It was held that significant VOC reductions in water based paints would mean lower propylene glycol levels and that, if this solvent was not exempt, this would result in impaired application properties in hot weather.

9.4.4 Protective and Marine Coating Manufacturer Views

Marine are divided into two main segments, namely Commercial and Yacht & Pleasure craft, the latter comprising less than 20% of the marine coating volume sales (not reflected in the Phase 1 Data).

The commercial marine segment is characterised by the following elements which are of relevance in terms of potential future VOC controls:

- The Commercial Marine market is primarily supplied by global paint companies that have major product platforms that have been formulated to meet EU or US regulation.

- Specification & user requirements are predominately global.

- Underwater systems have performance testing & regulatory requirements that preclude rapid product changes.

Yacht and Pleasure Craft have the following important characteristics locally:

- Applied at professional applicator facilities and by DIY owners.

- Technology derives in part from Commercial Marine (global) and products from other market segments.

- Underwater systems have performance testing & regulatory requirements that preclude rapid product changes.

- Products manufactured in Australia for export should be exempt from Australian VOC regulations.

The Protective Coatings market is primarily supplied by global paint companies that have major product platforms that have been formulated to meet future EU or current US regulation. The protective coatings sector representatives therefore argue that products manufactured in Australia for export should be exempt from Australian VOC regulations.

9.5 VOC Definition and Test Method

VOCs are defined in various ways, ranging from definitions based on vapour pressure (>10 hPa at 20℃), boiling point (<250℃ or 280℃), phot ochemical oxidant creation potential (POCP) and may include exemptions of specific compounds. A detailed discussion of the VOC definitions adopted in Australia and abroad is given in **Section 5.1.1**.

The most suitable VOC definition depends primarily on the approach to VOC regulation adopted, as discussed previously. Generally coating manufacturer representatives consulted with during the study expressed a preference for the use of the APAS definition, as found in D181. Reasons for this are likely to include familiarity with this definition, and similarly of this definition with that adopted by the EU.

The more general definition applied by APAS and the EC 2004 Directive are suited to a mass-balance total VOC approach to VOC regulations. The VOC definition adopted should however be seen as being distinct from the actual expression of VOC limits which may make provision for the exemption of compounds, as in the case of the US.

The method for determining compliance with VOC limits is also dependent on the definition and overall approach to regulation adopted. VOC quantification methods typically include actual measurement and mass-balance calculation approaches. Measurement methods involve the submission of ‘ready for use’ product to accredited laboratories for testing (eg. According to so-called Method 24, as is implemented in the US and proposed for adoption in Canada). Mass balance calculation protocols involve the calculation of VOC contents of ‘ready for use’ products based on the composition of the ingredients of such products.

A mass balance approach was favoured above an analytical measurement method by several paint manufacturers due to it being simpler and more cost-effective thus reducing compliance demonstration costs.

9.6 Broad versus Detailed Coating Categories

EU VOC limits are specified for broad coating categories that make no distinction between general use coatings and some niche speciality coatings. In the US and CARB approaches, limits are given for a detailed list of specific coating types.

Both approaches have advantages and disadvantages. The use of broad coating categories may require the specific exemption of niche speciality coatings that require higher VOC concentrations, but are less likely to require frequent revision as coating technologies evolve. As part of the recent CARB Architectural Coating SCM revision, for example, 15 categories were eliminated with ten new categories added. It is interesting to note that some of these changes involved the replacement of several detailed product types with broader coating categories such as in the case of wood coatings.

9.7 Effective Date and Transitional Arrangements

The need for transitional arrangements, specifically lead times for phase in of low VOC products was emphasised by certain market segments, particularly segments with significant proportions of locally produced products, notably Architectural and Decorative.

Representatives from the Architectural and Decorative sector were of the view that at least 5 years lead time would be needed to facilitate the reformulations necessary to meet VOC limits, considering also delays due to the NICNAS process. Other sectors may also require long lead times for coating end users to change their operations to suit low VOC technologies, eg. Smash repairers, in the case of automotive refinish coating use.

A ‘sell through period’ may be adopted, to provide industry with a reasonable amount of time to market and sell non-compliant coating volumes manufactured prior to the prohibitions applicable to the manufacture and import. The length of this period should be determined in consultation with affected parties. In Canada, industry stakeholders expressed concern about the proposed one-year sell-through period, stating that this duration would be insufficient to avoid significant costs of disposal of non-compliant coating volumes. This prompted Environment Canada to propose a two-year sell-through period (Environment Canada, 2008).

9.8 Application of Regulations (including Exemptions)

Product-based VOC concentration limits are typically applicable to manufactured or imported coatings, but exclude coatings imported or manufactured exclusively for export.

Aerosol coatings and adhesives are generally addressed by separate control measures.

Specific architectural coatings, sold in containers with volumes of one litre or less are typically exempt from regulation; so-called ‘small container exemption’. This exemption is useful to allow the continued manufacture of identified niche and speciality products that require higher VOC concentrations, for which the costs of compliance would be high with small volumes of emissions being reduced.

The potential of exempting certain end users which could be negatively impacted could be considered. Care should however be taken not to exempt users which are potentially significant sources of VOC emissions. Automotive Refinishing manufacturers, for example, generally agreed that body shops should not be exempted from the use of low VOC technology coatings, since this would be counter-productive as these shops are significant sources of VOC emission with few of them having effective VOC controls in place.

10 Glossary

Acrylic

A type of resin used in solvent borne and waterborne industrial and decorative coatings and inks. Often reacted with other resin types to achieve the right properties.

Alkyd

A type of resin used particularly in decorative gloss paints some (generally lower performance) industrial coatings and inks. It may air dry or to be staved to cure. It is generally solvent borne, but can be used in water born systems.

APAS

Australian Paint Approvals Scheme, a government based, voluntary performance specification scheme.

APMF

The Australian Paint Manufacturers Federation (APMF), was established in 1947 to represent the interests of Australian paint manufacturers. It membership includes over 50 paint manufacturers, including all the major paints.

Basecoat (BC) / Clear

A paint system in which the colour effect is given by a highly pigmented basecoat. Gloss and durability are given by a subsequent clearcoat.

Binder

A binder is generally a "resin", a high molecular weight hydrocarbon which forms the integral film of a coating by curing. Resins may be thermoplastic (PVC), which means that they can be cycled through solidifying/softening without significant chemical change; or they may be thermosetting (e.g. epoxy) resins which change their chemical structure on curing to a solid film which cannot be re-melted. A few binders are wholly or partly inorganic, such as cement or ethyl zinc silicate.

CEPE

The pan-European trade association of the coatings industry, the Confederation European des Associations de Fabricants de Pientures, d'Encres d'Impriemerie et de Couleurs d'Art includes as its members the national trade associations and, as Corporate Associate Members, many of the major pan-European coatings producers. It promotes the interests of the industry, particularly with the Community and other international organisations. Health, safety and environmental issues are of particular concern.

Clearcoat

The top, clear, coat of a car paints system. Used in vehicle refinishing, as well as for original painting of cars.

Coating System

Two or more layers of coatings, generally different coatings serving different purposes: for example, suitable pre-treatment followed by a primer to provide adhesion and corrosion resistance, then an undercoat to obliterate and bring the colour closer to the final shade required, and a topcoat to provide the aesthetic appearance over the life of the coating.

Corrosion Resistance

The ability of a coating system to slow corrosion, often achieved by the inclusion of pigments based on metallic zinc or compounds of zinc, lead or calcium. Good adhesion and water resistance of the coating is generally also important, to prevent access of moisture to the metal substrate. Other systems offer corrosion resistance such as coating with zinc (galvanising), and may be used in isolation or in conjunction with a coating system.

Curing

Converting the wet or powder applied coating to a dry, continuous film by the application of heat, a reactive chemical, some form of radiation or atmospheric action.

Decorative Market

Products are designed for either interior or exterior use, although "exterior use" products can be used in interior applications. Products specifically for interior use include emulsion paints for walls and ceilings and a variety of special paints for specific applications such as in kitchens or bathrooms. Products for exterior use include gloss and masonry paint, and a wide range of varnishes and stains for wood care. The market is made up of DIY and Trade users.

Diluent

A liquid part of wet paint which does not contribute as a solvent to dissolving the resin, but nevertheless reduces the viscosity of the paint to help with application.

Dispersion

The process of separating pigment agglomerations into smaller particles and mixing them into the binder.

DIY

The DIY market is made up of users who apply paint to their homes themselves. They are supplied through retail outlets such as multiple retailers, DIY specialist chains, supermarkets, department stores, retail cash and carries and independent retailers.

Emulsion

A stable mixture of two liquids, which will not dissolve in one another. In making emulsion paint, water and various solvents, which mix with water are the 'continuous phase' which holds tiny droplets of liquid resin polymer dispersed.

Enamel

Broad classification of paints that dry to a hard, usually glossy finish. Most equipment-coating enamels require baking. Enamels for walls do not.

Epoxy

A family of resins of many types, usually with very good adhesion and chemical protection, but only moderate resistance to light. Normally used in two-pack form with another resin. Used in powders for interior to under-the bonnet car applications.

Evaporation

Occurs when part of the liquid in a coating becomes a vapour (either at normal temperatures or with heating) and disperses, generally in the atmosphere.

Extruder

Equipment widely used in the plastics industry for manufacturing plastic items adapted by powder coatings manufacturers for dispersing pigments and resin. The pigment and resin mixture is forced down a tube by one, or often two, Archimedes screws, which melt and thoroughly mix together the powder as it passes along the barrel.

Film

The dried coating, which appears to be flat and two dimensional, but whose appearance and properties differ between the surface, the body of the film and the interface with the substrate. If the film is not dried, it is generally called a 'wet' film.

Gloss

The proportion of light reflected from a beam of light falling at an angle on the surface. Gloss may be reduced by increasing pigmentation, changing the types of pigment used (for example, by the use of matting agents), or by chemical additives.

High Solids

Coatings in which the solid or potentially solid parts (mainly resins and pigments) from a large part (usually over 75%) of the coating's volume.

High Speed Disperser

A powerful mixer for liquid coatings, which can be used for primary or complete dispersion, depending on the coating involved. A vertical shaft with a blade (which may be in a specially designed cage) can be lowered into the mixture of resins, thinners and pigments. Rotating at high speed, the blade, if positioned at the right height, can create a severe vortex, circulating the coating and dispersing the pigments.

Industrial Market

Products are often designed for users' specific applications, tailored specifically for the method of application and curing to be used, as well as for the end use of the cured coating. The market is very diverse, but further details of groups of users can be found under Protective coatings, Marine, Transport, Engineering, Construction, Furniture, Plastics, Electronics and Packaging.

Inorganic

Not chemically based on or derived from hydrocarbons.

Linseed Oil

Oil from the seed of the flax plant historically used after heat treating as a medium for varnish and coatings.

Marine

The marine paint market is made up of users who apply paint above and below the waterline of ships and boats. The market can be split into three sectors, based on the size of the vessel being painted. At the top of the scale are the large passenger, cargo or naval vessels which are often international in their movements and need to be dry docked, often anywhere in the world, for major painting. In the middle are smaller boats, such as fishing boats, which can be hauled out of the water on a slipway. At the bottom of the scale are leisure craft, maintained by their owners or by specialist shipyards. Costing are applied by spray, roller and brush.

Markets

Groups of coatings users with similar needs. The groups may be subdivided into several levels of 'segments'. Key coatings markets are decorative (subdivided into DIY and trade), and industrial (protective coatings, marine, automotive, heavy transport, agricultural construction and earthmoving equipment, vehicle refinishing, construction, general engineering, furniture, plastics and packaging).

Medium

Another word for 'binder' or 'resin', but often used to describe a mixture of resins for use in a particular coating.

Moisture Curing

A coating system, based on isocyanates, which cures on exposure to water or water vapour in the air to form a polyurethane.

Nitrocellulose

Made by reacting cellulose (from wood pulp or cotton) with nitric and sulphuric acids, it is a highly inflammable resin if allowed to dry. For this reason it is always kept dampened with solvent or water. It is generally mixed with other resins and plasticisers (to give the film flexibility).

Opacity

The ability of a coating to hide or obliterate the substrate. Film thickness increases opacity, but performance and economics may demand high opacity at relatively low film thickness', such as in litho or gravure inks. Pigments are key to opacity, with different pigments offering different degrees of opacity, by virtue of their different light refracting (bending of light beams as they pass into or out of pigment particles) or light absorbing powers, but different media will also have some effect.

Organic

Chemically based on or derived from hydrocarbons.

Packaging Market

The packaging market is made up of users who manufacture packaging out of metal, plastic or paper, and coat their packaging for decorating, information and protection. Major coatings users include can and drum makers, carton makers and plastic packaging specialists. Coatings used include paints, inks and varnishes.

Pigment

A fine dry powder which, when mixed with a binder, gives a coating colour (including black or white). They are generally opaque and give opacity to the coating, and may also give other properties such as corrosion resistance.

Pine Resin

The sticky exudation from pine trees.

Plastics Market

The plastics market is made up of users who coat plastic components and furniture using clear or pigmented coatings. Coatings are generally applied by spray and cured by air drying, moderate heat or UV.

Polyester

A resin with a mix of properties which make it attractive as a general purpose industrial coating for powder, coil coating, general metal finishing and wood finishing. It has good exterior durability but lower chemical resistance than epoxy.

Polymerise

The process of forming a polymer from monomers of simpler polymers. The process may form chains, with or without branches, rings, nets or honeycomb structures.

Polyurethane

A widely used resin with good properties of adhesion, flexibility, hardness and weathering. They may be two component, moisture curing or single component resins used in stoving applications.

Polyvinyl Acetate

A polymer commonly used in emulsion paints, also known as PVA.

Polyvinyl Chloride

PVC, a polymer used in coil coatings giving high flexibility and, in thick films, very good durability.

Powder Coating

A coating made of finely ground particles of solid paint which are generally sprayed electrostatically to cover the article being painted. The powder coated article is then stoved, when the powder melts, flows out to form a continuous paint film before reacting chemically to become a solid inert coating.

Pre-finishing

Painting (and/or laminating with sheet plastic) metal in sheet, strip or coil form before forming the metal into cladding or finished components. Also known a coil coating when using continuous coil as the substrate.

Pre-Mixer

A process of mixing liquid, paste or powder coating components intimately to prepare them for dispersion.

Pre-treatment

A process prior to painting in which the steel or aluminium substrate is cleaned and treated with a solution (usually) of corrosion inhibiting chemicals such as acid phosphates or chromate's. Can also be used to describe flame or electrical treatment of plastic prior to coating.

Primer

A coating which ensures adhesion between the substrate and the remainder of the coating system. Often used on metals, where it may be formulated to give improved corrosion protection, and on wood, prior to the application of pigmented coatings.

Protective Coatings

The protective coatings market is made up of users who apply protective and anti-corrosive coatings, usually to steel and concrete structures. Most users are highly specialist painting contractors working on structures where the standard of protection required is very high and access is often difficult. These include bridges, heavy industrial plants, offshore drilling rigs and production platforms. Coatings are applied by spray whenever possible, and by roller or brush when it is not.

PVA

A polymer commonly used in emulsion paints, made from polyvinyl acetate.

PVC

Polyvinyl chloride, a polymer used in coil coatings giving high flexibility and, in thick films, very good durability.

Resin

A high molecular weight hydrocarbon which forms the integral film of a coating by curing. Resins may be thermoplastic (PVC), which means that they can be cycled through solidifying/softening without significant chemical changes; or they may be thermosetting (e.g. epoxy) resins which change their chemical structure on curing to a sold film which cannot be re-melted.

Safety Data Sheets

A document providing storage and handling instructions for raw materials and finished trade and industrial coatings, and inks. Particular hazards, if any, will be described in detail, together with first aid instructions.

Sand Mill

A form of vertical bead mill, in which the coating, pre-dispersed on a high speed mixer, is pumped through a tube packed with beads rotated by a central agitator. The tuber is cooled by water to keep the temperature controlled.

Solvent

Although water is sometimes a solvent for certain resins, usually refers to an organic liquid in which resins may be dissolved and which evaporates readily to the atmosphere or when heated, leaving a film of coating.

Solvent Based

A coating system in which the resins are dissolved in non-aqueous solvents.

Spraying

The process of coating a surface by breaking up a coating into small particles (in the case of a liquid coating, by forcing it through a fine nozzle) which are then directed, possibly with the help of a current of air or an electrostatic charge, onto the surface.

Substrate

The surface onto which a coating system is placed, and to which it adheres.

Tall Oil

Obtained as a by-product of making wood pulp, this is an important ingredient of alkyd resins.

Thinner

A liquid which dilutes a liquid coating system, making it easier to apply, and sometimes aiding adhesion by carrying the binder into the substrate.

Titanium Dioxide

Also called by its chemical name Ti02, this pigment has been the key to moving away from the old creamy or greyish whites (still to be seen in, and still faithfully made by paint manufacturers for, stately homes). Its performance is due to its extremely high refractive index, which means that once light gets into a crystal of Ti02 it has great difficulty, getting out again, giving a coating of high opacity as well as being bright and white. Being chemically very stable, it weathers well and does not stain.

Topcoat

The final, top, coat in a coating system, providing the long term aesthetic appearance of the coating.

Turpentine

The earliest solvent, it was made by distilling parts of pine trees, particularly the semi-liquid resinous exudation.

Two Component, or Two-pack

A coatings system in which two components of the system are manufactured and supplied separately. On mixing the two components prior to application, a chemical reaction occurs over a period of time (the 'pot life') which may be measured in hours or seconds. This reaction (which may be accelerated by stoving) results in the coating forming a continuous dry film.

Ultra Violet (UV Light)

An electromagnetic radiation, similar to visible light but of shorter wavelength, which is emitted from the sun and from specially designed lamps. It often has an effect on resins, in some cases causing them (with the help of other chemicals called photoinitiators) to polymerise. In other cases natural UV can cause the breakdown over time of the resin in the cured film. The polymerising property is used in UV curing systems, while additives (UV absorbers) check the destructive properties of natural UV.

Ultrafiltration

A process utilising membrane technology to recover usable paint from certain paint wastes, such as surplus spray ("overspray") from wet paint spraying and excess coating ("Cream coat") from Electro-deposition. These wastes are collected in water. Ultra-filtration concentrates the wash water back to the original application constants of the coating. Not only does this system save paint, the water can be re-used and it reduces the waste which has otherwise to be treated and sent to landfill.

Undercoat

An intermediate part of a coating system, generally applied over primer or previously painted surfaces, which has high obliterating power and ability to provide a more level surface for the topcoat. In protective coating and industrial applications it is often called a 'build coat'.

Varnish

A mixture of binder and thinner in a clear or coloured liquid which forms a transparent film on drying.

Vehicle Refinish Paint

Coatings applied to a vehicle after its construction and initial painting: may be applied in car plants to repair damage, but is more usually applied in body shops to repair damage or change appearance.

Viscosity

The ability of a liquid coating to resist forces causing them to flow. Water has a relatively low viscosity, whilst some resins such as pitch are very viscous. Viscous coatings will resist forces such as brushes or rollers used to apply them. Viscosity usually reduces as temperature rises, so some coatings (such as powder coatings) only become liquids as high temperatures. If the viscosity is too low, however, the coating may not stay on the substrate at the correct thickness and evenness, so a balance is required.

VOCs

Volatile organic compounds are any organic liquid and/or solid that evaporates spontaneously at the prevailing temperature and pressure of the atmosphere with which it is in contact. VOCs can contribute to poor air quality by raising ozone concentrations at ground level in certain climatic conditions.

Water Based

A coating which is carried in water as the main liquid component. The coating resin may be dissolved in the water (although this is unusual), or it may be emulsified, or it may be dispersed in small particles.

Water Resistance

Coatings films absorb and transmit water and water vapour. Sometimes this property is used positively as, for example, in emulsion paints which allow new plaster to dry out through them, or microporous wood coatings which allow the wood to "breathe". Generally when formulating exterior coatings, the aim is to maximise the water resistance of the film.

Weathering Resistance

Coatings systems are broken down over time by the action of UV light, atmospheric moisture and acidity, and accelerated by infra-red radiation. For coatings to be used outside, it is important to slow the break down of the coating as much as possible. The is done by a combination of weathering-resistant binders and pigments, the use of special additives such as UV absorbers and the design of the coatings system itself, including its thickness.

White Spirit

A petroleum distillate used as a solvent and cleaner for alkyd and other resins, particularly for brushing applications.

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Appendices

Appendix 1
Phase 1 Data Survey

ENVIRON

6 August 2008 Our Ref: AS120900_Surface Coating Survey_6Aug08

Dear Sir, Madam,

Re: Information Required in respect of the *Volatile Organic Compounds from Surface Coatings Project*

Environ Australia (Pty) Ltd (hereafter "Environ") has been commissioned by the Environment Protection Heritage Council to undertake a project entitled *Volatile Organic Compounds (VOCs) from Surface Coatings – Assessment of the Categorisation, VOC Content and Sales Volumes of Coatings Products Sold in Australia*. This study aims to investigate the best possible policy options for a product-based approach to reducing emissions of VOCs from surface coatings, with the intention of limiting the potential for adverse environmental and human health effects associated with the formation of tropospheric ozone.

A key initial aspect of the project includes the inventory and categorisation of surface coating products manufactured in and imported into Australia. It is in this regard that your cooperation is currently requested.

Environ is working in cooperation with the Australian Paint Manufacturers Federation (APMF) and the Inter-Company Comparison Centre (ICC) to collate the information required for the project. The ICC has a long history of collating and aggregating surface coating production and industrial product sales information. The ICC provides assurances of confidentiality, with no individual company's figures being evident within the aggregated data (*personal communication*, David Hayne, ICC, 5 Aug 2008).

The data collation process is as follows:

- Collation and aggregation of data by ICC and submission of aggregated data to APMF
- APMF to forward the aggregated data to Environ.

The information requested is documented overleaf and in the associated spreadsheets. The due date for data submission to the ICC is: **WEDNESDAY 20TH AUGUST 2008**.

We trust that the request for data provision will meet with your consideration. Please contact me on (02) 9954 8131 or yscorgie@environcorp.com.au should you have any queries.

Yours faithfully,
ENVIRON Australia Pty Ltd

Yvonne Scorgie
Manager, Air Quality

EPHC Study on VOCs from Surface Coatings **-** *Assessment of the Categorisation, VOC Content and Sales Volumes of Coating Products Sold in Australia*

Information Requirements

Return by Date: **WEDNESDAY 20TH AUGUST 2009**

Please return to: Inter Company Comparison Centre
P O Box 192
Malvern VIC 3144
Tel: (03) 9509 0054
Fax: (03) 9509 0754
Email: interccc@iprimus.com.au
Contact person: David Hayne
Returns can be by email, mail or fax. Email would be preferred.

Confidentiality: Your completed form will be maintained confidentially b the Inter Company Comparison Centre.

Enquiries: Should you have difficulty in completing this form you should contact the Inter Company Comparison Centre (David Haynes) as per the contact details given above or Environ Australia Pty Ltd (Yvonne Scorgie; Tel: 02 9954 8130; yscorgie@environcorp.com.au).

INSTRUCTIONS RELATING TO ALL SECTIONS:

- **Reporting Period**: Figures are for a Jan to Dec 2007 (ie 2007 calendar year).
- **Volume units:** All production and sales figures to be expressed in LITRES (except spraypacks to be entered as units).
- **Conversions to litres:**
    - Paints in paste form to be in litre equivalents converted at 1 litre per 1 kg.
    - Paints in powder form to be in litre equivalents converted at 1 litre per 1 kg.
- **Estimates:** If you cannot supply actual figures, please submit careful estimates.
- **Definition of Volatile Organic Compounds (VOCs)**, as per the Australian Paint Approval Scheme (APAS) Document D181, which is expressed as follows:

  Volatile organic compounds (VOCs) are considered to be organic compounds in paint formulations that have:

  (a) a vapour pressure of >0.01 mm Hg at 21°C, or

  (b) an initial boiling point of <250°C measured at a standard pressure of 101.3 kPa.
- **VOC volume units:** Total VOCs should be expressed in kilograms
- **NOTE:** If VOC content data are only available based on an alternative VOC definition – please highlight this in your submission and specify the VOC definition used.

SECTION 1 – PRODUCTION DATA

Please provide volumes of surface coating products manufactured within Australia, and information on the total VOC content of such product categories by completing the **Production Data** spreadsheet.

To aid reporting, the Inter Company Comparison (ICC) Centre production categories were adopted in all instances. Notes are provided in the spreadsheet to describe categories.

SECTION 2 – SALES DATA (FOR AUSTRALIA & ABROAD)

Please provide information on surface coating products (produced in Australia) which are sold both within and outside of Australia by completing the **Sales Data** spreadsheet.

The basis for the product categories given in the spreadsheet is as follows:

- Architectural & Decorative Paints, Enamels and Woodcare categories are as per the Infomark Pty Ltd categories, except that certain of the categories are expressed separately for water- and solvent-based.
- Industry categories are as per the Inter Company Comparison (ICC) Centre Quarterly Industrial Sales Statistic Survey categories.

If the volumes of product sold by state and/or exported are not known separately, please complete the "Total Sales" columns only.

For exports, please provide the names of the final destination countries (if known).

SECTION 3 – IMPORT DATA

Please provide information on surface coating products imported into Australia by completing the **Import Data** spreadsheet.

The basis for the product categories given in the spreadsheet is the same at that given for Sales Data (Ref Section 2).

Please specify the volumes and total VOC contents for product categories as total imports and by country of origin (where known).

SECTION 4 – SOLVENT USAGE DURING PRODUCTION

Please complete the **Solvent Usage** spreadsheet for all solvents in the surface coating products produced during 2007.

Data are requested for manufacturer-defined product categories for which solvent usage data are readily available.

Information on the VOC content and VOC reactivity of the solvent are requested if known.

SECTION 5 – ADDITIONAL INFORMATION (OPTIONAL)

- Growth / decline projections for manufacture, import and/or use by product categories. This information can be provided qualitatively. The aim being to identify product categories expected to experience significant growth or decline in the forseeable future.
- Product reformulations or product substitution likely to be implemented to meet potential future VOC limits (whether voluntary or mandatory). Research completed in respect of changes considered to possibly meet US, EU, envisaged future APAS or other limits or to reduce the reactivity (ozone creation potential) of products could be reported on.
- Technical feasiblity & economic cost of realising reductions in VOC content (findings of internal studies, where available).

ENVIRON

SECTION 1 – PRODUCTION DATA

		Production (2007)	
ICC No.	**Categories:**	**Volume Lts**	**Total VOC Kg**
	A & D Paints, Enamels & Clears		
1	Solvent thinned		
2	Water thinned		
3	Thinners for A & D paints, enamels & clears		
	Automotive		
4	Automotive		
5	Automotive thinners		
	Other Industrial Points, Enamels & Clears		
6	Fast dry alkyd topcoats and primers		
7	Nitocellulose lacquers		
8	Other industrial		
9	Thinners		
	Heavy Duty Coatings		
10	Two pack products		
11	Single pack products		
12	Zinc rich products		
13	Marine coatings		
14	Road marking paint		
15	Thinners		
	Timber Finishes (Excluding Wood Preservatives)		
16	A & D timber finishes		
17	Industrial finishes		
18	Floor finishes		

*See Notes

PRODUCTION DATA NOTES:

General

Reporting period	Figures are for a 12 month period (Jan - Dec 2007), i.e. 2007 Calendar year
Volume units	All volumes to be expressed in LITRES (Spraypacks as units) Paints in paste form to be in litre equivalents converted at 1 litre per 1 kg Paints in powder form to be in litre equivalents converted at 1 litre per 1 kg.
Definition of VOCs	Volatile organic compounds (VOCs) are considered to be organic compounds in paint formulations that have (a) a vapour pressure of >0.01 mm Hg at 21℃, or (b) an initial boiling point of <250℃ measured at a standard pressure of 101.3 kPa.
VOC volume units	Total VOC contents should be expressed in kilograms

-

Architectural & Decorative

a) Solvent thinned

Such as
* Primers & undercoats
* Finishing coats, pigmented full gloss (over 50 units of 60 degree HEAD)
* Finishing coats, pigmented other than full gloss
* Finishing coats, clears (include varnishes and clear plastic coatings such as floor treatment compounds and two-pack type coatings)

Exclude
* Heavy duty coatings (include separately)

b) Water thinnned

Such as
* Plastic latex primers & undercoats
* Plastic latex flat finishing coats
* Plastic latex finishing coats other than flat (satin, semi-gloss, gloss)
* Water based other than plastic latex

Exclude
* Heavy duty coatings (include separately)

Industrial Paints, Enamels & Clears

a) Automotive

Such as
* Primers and undercoats
* Finishing coats, nitro-cellulose lacquers
* Finishing costs, other than nitro-cellulose lacquers

c) Other Industrial

e.g. fast dry enamels, etching paints, baking enamels, drum enamels and coil coatings

Such as
* Primers and undercoats
* Finishing coats - nitro-cellulose lacquers clears
* Finishing coats - nitro-cellulose colours
* Finishing coats - other than nitro-cellulose lacquers clears
* Finishing coats - other than nitro-cellulose lacquers colours

Exclude
* Heavy duty coatings (include separately)
* Marine Coatings (include separately)

Heavy Duty Coatings

Sometimes referred to as "protective coatings"

Such as
- Vinyl, epoxies and polyurethanes etc
- Zinc rich paints
- High build epoxies and high build chlorinated rubber

- Topcoats in two-pack systems, including polyurethane and epoxy enamel topcoats.
- Specialty coatings specifically designed for the protection of interiors and exteriors of
- buildings, plant and equipment, pipe lines, tanks, dams, off-shore structures e.g. rigs, fixed or mobile
- Road -marking paint

d) Marine Coatings	Includes primers, undercoats, underwater compositions, boot toppings, deck paints & varnishes

Timber Finishes

a) Architectural & Decorative	*Such as* * Wood stains (water & solvent based) * Varnish (water & solvent based)
b) Industrial	*Such as* * Wood stains (spirit and nitro cellulose based) * Varnish (nitro cellulose lacquers)
c) Floor Finishes	*Such as* * Water & solvent based

SECTION 2 – SALES DATA

Architectural & Decorative Paints & Enamels

	TOTAL LOCAL SALES		NSW & ACT	VIC & TAS	QLD & NT	SA	WA	EXPORTS			TOTAL SALES (within & oustide of Australia)	
Category - A & D Paints & Enamels*	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Volume Lts**	**Volume Lts**	**Volume Lts**	**Volume Lts**	**Volume Lts**	**Total VOC Kg**	**Name(s) of Final Destination Countries**	**Volume Lts**	**Total VOC Kg**
Paving Paint: solvent-based												
Paving Paint: water-based												
Roof Paint: solvent-based												
Roof Paint: water-based												
Fence finishes												
Specialty finishes												
"Heavy end" texture coatings												
Metal finishes												
Spraypacks												
Prepcoats: water-based												
Prepcoats: solvent-based												
Ceiling Paint/Flat topcoats												
Door,Window,Trim: water-based												
Door,Window,Trim: solvent-based												
Interior topcoats: water-based												
Exterior topcoats: solvent-based												
Other												

Architectural & Decorative Woodcare

	TOTAL LOCAL SALES		NSW & ACT	VIC & TAS	QLD & NT	SA	WA	EXPORTS			TOTAL SALES (within & oustide of Australia)	
Category - A & D Woodcare*	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Volume Lts**	**Volume Lts**	**Volume Lts**	**Volume Lts**	**Volume Lts**	**Total VOC Kg**	**Name(s) of Final Destination Countries**	**Volume Lts**	**Total VOC Kg**
Decking Paint: water-based												
Decking Paint: solvent-based												
Flooring: water-based												
Flooring: solvent-based												
Interior Stains: water-based												
Interior Stains: solvent-based												
Exterior Stains: water-based												
Exterior Stains: solvent-based												
Prepcoats: water-based												
Prepcoats: solvent-based												
Interior clears: water-based												
Interior clears: solvent-based												
Exterior clears: water-based												

*See Notes

Industrial

	TOTAL LOCAL SALES		NSW & ACT	VIC & TAS	QLD & NT	SA	WA	EXPORTS			TOTAL SALES (within & oustide of Australia)	
Category - Industrial	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Volume Lts**	**Volume Lts**	**Volume Lts**	**Volume Lts**	**Volume Lts**	**Total VOC Kg**	**Names of Final Destination Countries**	**Volume Lts**	**Total VOC Kg**
Automotive - OEM												
Primers and undercoats												
Topcoats												
Automotive - Car Refinish												
Primers and undercoats												
Topcoats												
Heavy Duty Coatings												
Protective Coatings (see notes)												
Marine Coatings (see notes)												
Other Industrial												
Primers and undercoats												
Finishing coats - Nitrocellulose lacquers												
Finishing coats - Other												
Road & Runway marking												
Can and Coil												
Flat Board Coatings												
Powder Coatings												
Other												
Thinners												
Thinners - for nitro cellulose coatings												
Thinners - for all other coatings												
Industrial Woodcare (see notes)												
Stains												
Clears												
Solid Colours												

Sales Data Notes:

Reporting period	Figures are for a 12 month period (Jan - Dec 2007), i.e. 2007 Calendar year
Volume units	All volumes to be expressed in LITRES (Spraypacks as units) Paints in paste form to be in litre equivalents converted at 1 litre per 1 kg Paints in powder form to be in litre equivalents converted at 1 litre per 1 kg.
Definition of VOCs	Volatile organic compounds (VOCs) are considered to be organic compounds in paint formulations that have (a) a vapour pressure of >0.01 mm Hg at 21°C, or (b) an initial boiling point of <250°C measured at a standard pressure of 101.3 kPa.
VOC volume units	Total VOC contents should be expressed in kilograms
Arch & Dec:	
Specialty Finishes	Primarily "Interior Textures" including all affects products such as 'suede', special finishes, craft, niche products etc. and all textured paint applied with a brush/roller.
"Heavy End" texture coatings	Textured paint applied with a trowel.
Metal Finishes	Topcoats applied to metal surfaces
Spraypacks	Report as units sold eg 2000 aerosol cans
Prepcoats	All interior and exterior primers, sealers and undercoats
Ceiling Paint/Flat Topcoats	All water based and solvent based flat paint
Door, Window, Trim Topcoats	Topcoats - includes all water based gloss, solvent based gloss and solvent based semi gloss paints.
Waterbased - Interior Topcoat	(Interior and interior/exterior topcoats) - includes all water based semi gloss and water based low sheen paints.
Waterbased - Exterior Topcoat	Exterior water based gloss, semi gloss and low sheen paints.
Arch & Dec Woodcare:	
A & D Woodcare	All products sold for application to interior or exterior timber as a clear or a stain. Do not include primers and undercoats eg pink primer, Acrylic Sealer Undercoat, that give solid cover and are to be topcoated with a paint finish.
Industrial:	
533.77 Protective coatings	Include: All heavy duty or protective coatings for structural steel, metal and concrete, plant and equipment, pipelines,bridges,wharf structures, oil, gas and mining industry applications where high performance air dried heavy duty coatings are required. Includes: epoxies, zinc rich coatings, polyurethanes, high performance air dried alkyd primers and topcoats and high temperature coatings. Exclude thinners. Report thinners under 533.57.
533.85 Marine coatings	Include: Primers and undercoats, underwater coatings, boot-toppings, deck paints, antifoulings, marine varnishes and superstructure paints for ships and yachts. Exclude thinners. Report thinners under 533.57.
Industrial Woodcase	Excluding Tinters and Thinners

SECTION 3 – IMPORT DATA

Architectural & Decorative

	TOTAL		USA		Singapore		New Zealand		Germany		France		Malaysia		Ireland		China	
Category - A & D Paints and Enamels*	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Total VOC Kg**
Paving Paint: solvent-based																		
Paving Paint: water-based																		
Roof Paint: solvent-based																		
Roof Paint: water-based																		
Fence finishes																		
Specialty finishes																		
"Heavy end" texture coatings																		
Metal finishes																		
Spraypacks																		
Prepcoats: water-based																		
Prepcoats: solvent-based																		
Ceiling Paint/Flat topcoats																		
Door,Window,Trim: water-based																		
Door,Window,Trim: solvent-based																		
Interior topcoats: water-based																		
Exterior topcoats: solvent-based																		
Category - A & D Woodcare*																		
Decking Paint: water-based																		
Decking Paint: solvent-based																		
Flooring: water-based																		
Flooring: solvent-based																		
Interior Stains: water-based																		
Interior Stains: solvent-based																		
Exterior Stains: water-based																		
Exterior Stains: solvent-based																		
Prepcoats: water-based		N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A
Prepcoats: solvent-based																		
Interior clears: water-based																		
Interior clears: solvent-based																		
Exterior clears: water-based																		

Architectural & Decorative (continued)

	Ireland		China		Italy		UK		Other (please specify here)	
Category - A & D Paints and Enamels*	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Total VOC Kg**	**Volume Lts**	**Total VOC Kg**
Paving Paint: solvent-based										
Paving Paint: water-based										
Roof Paint: solvent-based										
Roof Paint: water-based										
Fence finishes										
Specialty finishes										
"Heavy end" texture coatings										
Metal finishes										
Spraypacks										
Prepcoats: water-based										
Prepcoats: solvent-based										
Ceiling Paint/Flat topcoats										
Door,Window,Trim: water-based										
Door,Window,Trim: solvent-based										
Interior topcoats: water-based										
Exterior topcoats: solvent-based										
Category - A & D Woodcare*										
Decking Paint: water-based										
Decking Paint: solvent-based										
Flooring: water-based										
Flooring: solvent-based										
Interior Stains: water-based										
Interior Stains: solvent-based										
Exterior Stains: water-based										
Exterior Stains: solvent-based										
Prepcoats: water-based		N/A		N/A		N/A		N/A		N/A
Prepcoats: solvent-based										
Interior clears: water-based										
Interior clears: solvent-based										
Exterior clears: water-based										

Industrial

		TOTAL		USA		Singapore		New Zealand		Germany		France	
Code	Category - Industrial	Volume Lts	Total VOC Kg	Volume Lts	Total VOC Kg	Volume Lts	Total VOC Kg	Volume Lts	Total VOC Kg	Volume Lts	Total VOC Kg	Volume Lts	Total VOC Kg
	Automotive - OEM												
533.70	Primers and undercoats												
533.72	Topcoats												
	Automotive - Car Refinish												
533.71	Primers and undercoats												
533.74	Topcoats												
	Heavy Duty Coatings												
533.77	Protective Coatings (see notes)												
533.85	Marine Coatings (see notes)												
	Other Industrial												
533.74	Primers and undercoats												
533.75	Finishing coats - Nitrocellulose lacquers												
533.76	Finishing coats - Other												
533.78	Road & Runway marking												
533.79	Can and Coil												
533.81	Flat Board Coatings												
533.89	Powder Coatings												
533.82	Other												
	Thinners												
533.56	Thinners - for nitro cellulose coatings												
533.57	Thinners - for all other coatings												
	Industrial Woodcare (see notes)												
533.84	Stains												
533.68	Clears												
533.83	Solid Colours												

Industrial (continued)

Code	Category - Industrial	Malaysia		Ireland		China		Italy		UK		Other (please specify here)	
		Volume Lts	Total VOC Kg	Volume Lts	Total VOC Kg	Volume Lts	Total VOC Kg	Volume Lts	Total VOC Kg	Volume Lts	Total VOC Kg	Volume Lts	Total VOC Kg
	Automotive - OEM												
533.70	Primers and undercoats												
533.72	Topcoats												
	Automotive - Car Refinish												
533.71	Primers and undercoats												
533.74	Topcoats												
	Heavy Duty Coatings												
533.77	Protective Coatings (see notes)												
533.85	Marine Coatings (see notes)												
	Other Industrial												
533.74	Primers and undercoats												
533.75	Finishing coats - Nitrocellulose lacquers												
533.76	Finishing coats - Other												
533.78	Road & Runway marking												
533.79	Can and Coil												
533.81	Flat Board Coatings												
533.89	Powder Coatings												
533.82	Other												
	Thinners												
533.56	Thinners - for nitro cellulose coatings												
533.57	Thinners - for all other coatings												
	Industrial Woodcare (see notes)												
533.84	Stains												
533.68	Clears												
533.83	Solid Colours												

Notes as per Sales Data Notes

SECTION 4 – SOLVENT USAGE DURING PRODUCTION

	Total			Volumes (Lts) per Product Category* (see notes)						
Solvent Type:	Volume Lts	Total VOC Kg	VOC reactivity (kg O_3/kg VOC)	Category 1 (name)	Category 2 (name)	Category 3 (name)	Category 4 (name)	Category 5 (name)	Category 6 (name)	Category 7 (name)

Notes:

Reporting period	Figures are for a 12 month period (Jan - Dec 2007), i.e. 2007 Calendar year
Volume units	All volumes to be expressed in LITRES
Definition of VOCs	Volatile organic compounds (VOCs) are considered to be organic compounds in paint formulations that have (a) a vapour pressure of >0.01 mm Hg at 21℃, or (b) an initial boiling point of <250℃ measured at a standard pressure of 101.3 kPa.
VOC volume units	Total VOC contents should be expressed in kilograms
Product Category#	Manufacturer-defined product categories for which solvent usage data are readily available
VOC reactivity	Refers to the tropospheric ozone formation potential of the VOCs contained in the solvent, expressed as kg of ozone formed per kg of VOC present. Include if known.

Appendix 2
Synopsis of Phase 1 Data

PRODUCTION DATA:

ICC No.	Categories:	Production Data for 2007 (as Surveyed)		Production Data for 2007 (scaled to reflect APMF Production Stats)		Average VOC Content (g/L)	Contribution to VOC Contents	
		Volume Lts	Total VOC Kg	Volume Lts	Total VOC Kg		% of sector VOCs	% of total VOCs
	A & D Paints, Enamels & Clears							
1	Solvent thinned	10,366,926	2,446,159	13,236,250	3,123,199	236(a)	56	6.7
2	Water thinned	103,023,251	1,961,702	112,913,582	2,150,027	19	39	4.6
3	Thinners for A & D paints, enamels & clears	435,959	378,177	344,402	298,755	867	5	0.6
	Total A&D	**113,826,136**	**4,786,038**	**126,494,234**	**5,571,981**			**12.0**
	Automotive			-				
4	Automotive	11,048,463	5,927,276	11,601,646	6,224,048	536	56	13.4
5	Automotive thinners	5,329,065	4,748,931	5,377,776	4,792,339	891	44	10.3
	Total Automotive	**16,377,528**	**10,676,207**	**16,979,422**	**11,016,387**			**23.7**
	Other Industrial Points, Enamels & Clears			-				
6	Fast dry alkyd topcoats and primers	3,298,690	1,750,349	10,519,009	5,581,591	531	27	12.0
7	Nitocellulose lacquers	463,883	301,774	168,513	109,624	651	1	0.2
8	Other industrial	20,974,459	8,230,677	28,308,491	11,108,656	392	54	23.9
9	Thinners	3,605,125	3,126,812	3,818,878	3,312,205	867	16	7.1
	Aerosols	3,235,000	450,000	3,235,000	450,000	139	2	1.0
	Total Other Industrial	**31,577,157**	**13,859,612**	**46,049,891**	**20,562,076**			**44.3**
	Heavy Duty Coatings							
10	Two pack products	6,929,056	1,688,736	6,851,221	1,669,766	244	27	3.6
11	Single pack products	3,270,605	646,619	4,376,318	865,225	198	14	1.9
12	Zinc rich products	1,079,838	300,270	675,887	187,944	278	3	0.4
13	Marine coatings	1,400,238	447,586	1,357,904	434,054	320	7	0.9
14	Road marking paint	4,010,050	188,109	6,139,923	288,019	47	5	0.6
15	Thinners	2,839,181	2,470,112	3,233,816	2,813,448	870	45	6.1
	Total Heavy Duty	**19,528,968**	**5,741,431**	**22,635,069**	**6,258,455**			**13.5**
	Timber Finishes (Excluding Wood Preservatives)							
16	A & D timber finishes	2,748,244	792,124	4,797,136	1,382,675	288	46	3.0
17	Industrial finishes	945,222	573,624	2,491,615	1,512,078	607	51	3.3
18	Floor finishes	1,740,344	170,292	907,366	88,785	98	3	0.2
	Total Woodcare	**5,433,810**	**1,536,040**	**8,196,117**	**2,983,538**			**6.4**
	Total All products	**186,743,599**	**36,599,328**	**220,354,733**	**46,392,437**			

(a) Average VOC content flagged as being too low during the Focus Group Meetings. Based on subsequence analysis, this value was estimated to be 417 g/L.

PRODUCTION DATA NOTES:

General

Reporting period	Figures are for a 12 month period (Jan - Dec 2007), i.e. 2007 Calendar year
Volume units	All volumes to be expressed in LITRES (Spraypacks as units) Paints in paste form to be in litre equivalents converted at 1 litre per 1 kg Paints in powder form to be in litre equivalents converted at 1 litre per 1 kg.
Definition of VOCs	Volatile organic compounds (VOCs) are considered to be organic compounds in paint formulations that have (a) a vapour pressure of >0.01 mm Hg at 21°C, or (b) an initial boiling point of <250°C measured at a standard pressure of 101.3 kPa.
VOC volume units	Total VOC contents should be expressed in kilograms

-

Architectural & Decorative

a) Solvent thinned

Such as
* Primers & undercoats
* Finishing coats, pigmented full gloss (over 50 units of 60 degree HEAD)
* Finishing coats, pigmented other than full gloss
* Finishing coats, clears (include varnishes and clear plastic coatings such as floor treatment compounds and two-pack type coatings)

Exclude
* Heavy duty coatings (include separately)

b) Water thinnned

Such as
* Plastic latex primers & undercoats
* Plastic latex flat finishing coats
* Plastic latex finishing coats other than flat (satin, semi-gloss, gloss)
* Water based other than plastic latex

Exclude
* Heavy duty coatings (include separately)

Industrial Paints, Enamels & Clears

a) Automotive

Such as
* Primers and undercoats
* Finishing coats, nitro-cellulose lacquers
* Finishing costs, other than nitro-cellulose lacquers

c) Other Industrial

e.g. fast dry enamels, etching paints, baking enamels, drum enamels and coil coatings

Such as
* Primers and undercoats
* Finishing coats - nitro-cellulose lacquers clears
* Finishing coats - nitro-cellulose colours
* Finishing coats - other than nitro-cellulose lacquers clears
* Finishing coats - other than nitro-cellulose lacquers colours

Exclude
* Heavy duty coatings (include separately)
* Marine Coatings (include separately)

Heavy Duty Coatings	Sometimes referred to as "protective coatings" *Such as* - Vinyl, epoxies and polyurethanes etc - Zinc rich paints - High build epoxies and high build chlorinated rubber - Topcoats in two-pack systems, including polyurethane and epoxy enamel topcoats. - Specialty coatings specifically designed for the protection of interiors and exteriors of - buildings, plant and equipment, pipe lines, tanks, dams, off-shore structures e.g. rigs, fixed or mobile - Road -marking paint
d) Marine Coatings	Includes primers, undercoats, underwater compositions, boot toppings, deck paints & varnishes
Timber Finishes	
a) Architectural & Decorative	*Such as* * Wood stains (water & solvent based) * Varnish (water & solvent based)
b) Industrial	*Such as* * Wood stains (spirit and nitro cellulose based) * Varnish (nitro cellulose lacquers)
c) Floor Finishes	*Such as* * Water & solvent based

LOCAL SALES DATA:

Segment	Category	Sub-Category	Total Local Sales Data as Surveyed		Average VOC Content (g/L)	Contribution to VOC Contents	
			Volume Lts	Total VOC Kg		% of sector VOCs	% of total local sales VOCs
Architectural & Decorative	Paving Paint: solvent-based		886,318	441,636	498	5.4	1.0
	Paving Paint: water-based		776,426	54,179	70	0.7	0.1
	Roof Paint: solvent-based		107,685	31,321	291(b)	0.4	0.1
	Roof Paint: water-based		258,158	21,727	84	0.3	0.1
	Fence finishes		1,016,133	5,417	5	0.1	0.0
	Specialty finishes		1,398,462	127,793	91	1.6	0.3
	"Heavy end" texture coatings		11,170,984	385,137	34	4.7	0.9
	Metal finishes		824,109	381,369	463	4.7	0.9
	Spraypacks		(c)	(c)	(c)		
	Prepcoats: water-based		11,975,413	524,983	44	6.4	1.2
	Prepcoats: solvent-based		2,565,973	1,184,941	462	14.5	2.8
	Ceiling Paint/Flat topcoats		16,572,016	402,302	24	4.9	0.9
	Door,Window,Trim: water-based		1,738,132	123,394	71	1.5	0.3
	Door,Window,Trim: solvent-based		5,140,252	2,019,352	393	24.6	4.7
	Interior topcoats: water-based		41,283,652	1,263,430	31	15.4	3.0
	Exterior topcoats:watert-based		23,084,081	1,054,961	46	12.9	2.5
	Exterior topcoats: solvent-based		850	9	10	0.0	0.0
	Other		474,113	177,344	374	2.2	0.4
	Total Arch & Dec		**119,272,757**	**8,199,294**			
Architectural & Decorative Woodcare	Decking Paint: water-based		291,392	12,527	43	0.4	0.0
	Decking Paint: solvent-based		2,761,144	1,752,082	635	53.5	4.1
	Flooring: water-based		217,588	25,281	116	0.8	0.1
	Flooring: solvent-based		1,308,895	735,322	562	22.5	1.7
	Interior Stains: water-based		115,037	15,596	136	0.5	0.0
	Interior Stains: solvent-based		561,878	251,447	448	7.7	0.6
	Exterior Stains: water-based		160,799	15,557	97	0.5	0.0
	Exterior Stains: solvent-based		162,591	104,619	643	3.2	0.2
	Prepcoats: water-based		179,201	1,081	6(d)	0.0	0.0
	Prepcoats: solvent-based		45,517	22,084	485	0.7	0.1
	Interior clears: water-based		115,037	15,596	136	0.5	0.0
	Interior clears: solvent-based		406,470	244,157	601(e)	7.5	0.6
	Exterior clears: water-based		604,230	51,456	85	1.6	0.1
	Exterior clears: solvent based		64,929	27,563	425	0.8	0.1
	Total Arch & Dec Woodcare		**6,994,708**	**3,274,367**			

LOCAL SALES DATA (continued):

Segment	Category	Sub-Category	Total Local Sales Data as Surveyed		Average VOC Content (g/L)	Contribution to VOC Contents	
			Volume Lts	Total VOC Kg		% of sector VOCs	% of total local sales VOCs
Industrial	Automotive – OEM	Primers and undercoats	1,349,344	349,966	259	20.5	0.8
	Automotive – OEM	Topcoats	2,653,924	1,359,751	512	79.5	3.2
	Total Automotive OEM (excluding thinners)		**4,003,268**	**1,709,716**			
	Automotive - Car Refinish	Primers and undercoats	1,569,695	892,583	569	28.2	2.1
	Automotive - Car Refinish	Topcoats	4,106,141	2,268,539	552	71.8	5.3
	Total Automotive Refinishing (excluding thinners)		**5,675,836**	**3,161,121**			
	Heavy Duty Coatings	Protective Coatings	11,157,371	3,458,899	310	13.7	8.1
	Heavy Duty Coatings	Marine Coatings	2,048,546	669,848	327	2.6	1.6
	Other Industrial	Primers and undercoats	2,640,578	1,370,022	519	5.4	3.2
	Other Industrial	Finishing coats - Nitrocellulose lacquers	6,360	4,264	670	0.0	0.0
	Other Industrial	Finishing coats - Other	3,531,658	1,668,780	473	6.6	3.9
	Other Industrial	Road & Runway marking	4,123,426	316,516	77	1.2	0.7
	Other Industrial	Can and Coil	15,243,634	6,549,779	430	25.9	15.3
	Other Industrial	Flat Board Coatings	1,859,718	109,406	59	0.4	0.3
	Other Industrial	Powder Coatings	290,697	-	0	0.0	0.0
	Other Industrial	Other	4,642,212	197,150	42	0.8	0.5
	Thinners	Thinners - for nitro cellulose coatings	671,104	572,821	854	2.3	1.3
	Thinners	Thinners - for all other coatings	11,971,499	10,415,777	870	41.1	24.3
	Total Industrial & Protective		**58,186,803**	**25,333,262**			
	Industrial Woodcare	Stains	132,161	102,020	772	9.0	0.2
	Industrial Woodcare	Clears	1,306,756	798,916	611	70.3	1.9
	Industrial Woodcare	Solid Colours	455,893	235,383	516	20.7	0.5
	Total Industrial Woodcare		**1,894,810**	**1,136,319**			
ALL	**TOTAL**		**196,028,182**	**42,814,080**			

(b) Average VOC content flagged as being too low during the Focus Group Meetings. Based on subsequence analysis, this value was estimated to be 407 g/L and error in one dataset having been found.

(c) Spraypacks were reported in units with 3,738,554 units having been reported. Based on an assumed average spray can size of about 250 ml, the total volume of spray paint is estimated to be 934,639. The VOC data received was incomplete and could not be used.

(d) Average VOC content flagged as being too low during the Focus Group Meetings and estimated to be approximately 50 g/L.

(e) Average VOC content flagged as being potentially too high during the Focus Group Meetings and estimated to be approximately 450 g/L.

Sales Data Notes:

Reporting period	Figures are for a 12 month period (Jan - Dec 2007), i.e. 2007 Calendar year
Volume units	All volumes to be expressed in LITRES (Spraypacks as units) Paints in paste form to be in litre equivalents converted at 1 litre per 1 kg Paints in powder form to be in litre equivalents converted at 1 litre per 1 kg.
Definition of VOCs	Volatile organic compounds (VOCs) are considered to be organic compounds in paint formulations that have (a) a vapour pressure of >0.01 mm Hg at 21°C, or (b) an initial boiling point of <250°C measured at a standard pressure of 101.3 kPa.
VOC volume units	Total VOC contents should be expressed in kilograms
Arch & Dec:	
Specialty Finishes	Primarily "Interior Textures" including all affects products such as 'suede', special finishes, craft, niche products etc. and all textured paint applied with a brush/roller.
"Heavy End" texture coatings	Textured paint applied with a trowel.
Metal Finishes	Topcoats applied to metal surfaces
Spraypacks	Report as units sold eg 2000 aerosol cans
Prepcoats	All interior and exterior primers, sealers and undercoats
Ceiling Paint/Flat Topcoats	All water based and solvent based flat paint
Door, Window, Trim Topcoats	Topcoats - includes all water based gloss, solvent based gloss and solvent based semi gloss paints.
Waterbased - Interior Topcoat	(Interior and interior/exterior topcoats) - includes all water based semi gloss and water based low sheen paints.
Waterbased - Exterior Topcoat	Exterior water based gloss, semi gloss and low sheen paints.
Arch & Dec Woodcare:	
A & D Woodcare	All products sold for application to interior or exterior timber as a clear or a stain. Do not include primers and undercoats eg pink primer, Acrylic Sealer Undercoat, that give solid cover and are to be topcoated with a paint finish.
Industrial:	
533.77 Protective coatings	Include: All heavy duty or protective coatings for structural steel, metal and concrete, plant and equipment, pipelines,bridges,wharf structures, oil, gas and mining industry applications where high performance air dried heavy duty coatings are required. Includes: epoxies, zinc rich coatings, polyurethanes, high performance air dried alkyd primers and topcoats and high temperature coatings. Exclude thinners. Report thinners under 533.57.
533.85 Marine coatings	Include: Primers and undercoats, underwater coatings, boot-toppings, deck paints, antifoulings, marine varnishes and superstructure paints for ships and yachts. Exclude thinners. Report thinners under 533.57.
Industrial Woodcase	Excluding Tinters and Thinners

Appendix 3
Participants of the Focus Group Meetings, held 2nd and 3rd September 2008

Focus Group	Name:	Company:
Industrial Coatings	Michael Hambrook	APMF
	David Grubits	Akzo Nobel
	Rod Vockler	Dulux (Orica)
(Akzo Nobel; Dulux; Mirotone; PPG; Shell; Valspar; Wattyl)	Ian Crick	Dulux (Orica)
	Don Dennis	Mirotone
	Paul Adeney (Discussion Leader)	PPG
	Joe Lister	PPG
	Les Curnow	Protec
	Neil Unthank	Rohm & Haas
	Rod Boyd	Shell
	Bo Padkjaer	Wattyl
	Stephen Carter	Valspar
	Joseph Rodgers-Falk	Wattyl
Automotive	Michael Hambrook	APMF
	Stephen Read	Akzo Nobel
(Akzo Nobel; BASF Coatings; Concept; DuPont; PPG; Shell)	Kaj van Alem	Akzo Nobel
	Mark Wall	BASF Coatings
	Ian Johnson	BASF Coatings
	Paul O'Hara	Concept Paints
	Robert Ward	DuPont
	Owen Streatfeild	DuPont
	Paul Adeney (Discussion Leader)	PPG
	Joe Lister	PPG
	Rod Boyd	Shell
	Bo Padkjaer	Wattyl
	Joseph Rodgers-Falk	Wattyl
Architectural & Decorative	Michael Hambrook	APMF
	Rod Vockler	Dulux (Orica)
(Dulux; Haymes Paints; PPG; Shell; Wattyl)	Ian Crick	Dulux (Orica)
	Elizabeth Salter	Haymes Paints
	Paul Adeney	PPG
	Alan Kesby	PPG
	Rod Boyd	Shell
	Joseph Rodgers-Falk (Discussion Leader)	Wattyl
Marine & Heavy Duty Protective	Michael Hambrook	APMF
	Paul James	Hempel
(Hempel; International Paint; PPG; Shell; Wattyl)	Evert Hut	Hempel
	Shaun Mizis	International Paints
	Paul Adeney	PPG
	Ian Loutit (Discussion Leader)	PPG
	Bo Padkjaer	Wattyl
	Joseph Rodgers-Falk	Wattyl

Appendix 4
Phase 2 Data Survey

AUTOMOTIVE REFINING COATINGS - PRODUCTION VOLUMES (2007) AND SOLVENT CONTENT

Production / Solvents	**Solvent CAS number (if available)**	**Units**	**Production Volumes (litres, 2007) and Solvent Content (grams solvent / litre of product) by Automotive Refining Category:**													
			1K- Primers	**1K- Lacquers- Clear**	**1K - Lacquers - Colour**	**1K - Synthetic air dry enamels**	**1K- Thinners**	**2K - Primers - Urethane**	**2K - Primers - Others**	**2K - Basecoats**	**2K - Topcoats - Clears**	**2K - Topcoats - Colour**	**2K - Hardners - Isocyanates**	**2K - Hardeners - Other**	**2K - Thinners**	**Others (e.g. Cleaners, Enamels)**
Production Volumes	NA	litres														
Solvent 1		g/L														
Solvent 2		g/L														
Solvent 3		g/L														
Solvent 4		g/L														
Etc.		g/L														

Notes:
Provide the product volume data in litres for the 2007 calendar year.
List all solvent types used by replacing the "Solvent 1" label by the actual solvent name (e.g. xylene, toluene)
Try to provide solvents by specific chemical name rather than be trade name (where possible)
Provide CAS numbers where available

INDUSTRIAL COATINGS - ROAD RUNWAY MARKING - PRODUCTION VOLUMES (2007) AND SOLVENT CONTENT

Production / Solvents	Solvent CAS number (if available)	Units	Production Volumes (litres, 2007) and Solvent Content (grams solvent / litre of product) for ROAD & RUNWAY Categories:	
			Road & Runway Marking (water borne)	Road & Runway Marking (solvent borne)
Production Volumes	NA	litres		
Solvent 1		g/L		
Solvent 2		g/L		
Solvent 3		g/L		
Solvent 4		g/L		
Etc.		g/L		

INDUSTRIAL COATINGS - PRIMERS UNDERCOATS - PRODUCTION VOLUMES (2007) AND SOLVENT CONTENT

Production / Solvents	**Solvent CAS number (if available)**	**Units**	**Production Volumes (litres, 2007) and Solvent Content (grams solvent / litre of product) by PRIMERS & UNDERCOAT Categories:**												
			Alkyd 1K (water borne)	**Alkyd 1K (solvent borne)**	**Polyurethane 2K (water borne)**	**Polyurethane 2K (solvent borne)**	**Isofree 2K (water borne)**	**Isofree 2K (solvent borne)**	**Vinyl etch (water borne)**	**Vinyl etch (solvent borne)**	**Epoxy (water borne)**	**Epoxy (solvent borne)**	**Acrylics (water borne)**	**Acrylics (solvent borne)**	**Other (production volumes only)**
Production Volumes	NA	litres													
Solvent 1		g/L													NA
Solvent 2		g/L													NA
Solvent 3		g/L													NA
Solvent 4		g/L													NA
Etc.		g/L													NA
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INDUSTRIAL COATINGS - WOOD CARE - PRODUCTION VOLUMES (2007) AND SOLVENT CONTENT

Production / Solvents	Solvent CAS number (if available)	Units	Production Volumes (litres, 2007) and Solvent Content (grams solvent / litre of product) by WOOD CARE Categories:									
			Dye stains (water borne)	Dye stains (solvent borne)	Pigment stains (water borne)	Pigment stains (solvent borne)	Nitrocellulose & precatalyst (water borne)	Nitrocellulose & precatalyst (solvent borne)	Polyurethane 2K (water borne)	Polyurethane 2K (solvent borne)	Polyester (water borne)	Polyester (solvent borne)
Production Volumes	NA	litres										
Solvent 1		g/L										
Solvent 2		g/L										
Solvent 3		g/L										
Solvent 4		g/L										
Etc.		g/L										

INDUSTRIAL COATINGS - FINISHING COATS - PRODUCTION VOLUMES (2007) AND SOLVENT CONTENT

Production / Solvents	Solvent CAS number (if available)	Units	Production Volumes (litres, 2007) and Solvent Content (grams solvent / litre of product) by FINISHING COAT Categories:												
			Alkyd - water borne	Alkyd - solvent borne	Polyurethane 2K - water borne	Polyurethane 2K - solvent borne	Isofree 2K - water borne	Isofree 2K - solvent borne	Epoxy - water borne	Epoxy - solvent borne	Baking enamel - water borne	Baking enamel - solvent borne	Acrylics - water borne	Acrylics - solvent borne	Other (production volumes only)
Production Volumes	NA	litres													
Solvent 1		g/L													NA
Solvent 2		g/L													NA
Solvent 3		g/L													NA
Solvent 4		g/L													NA
Etc.		g/L													NA
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Notes:

It is recognised that certain product types may only be water or solvent borne. All product types were given for both bases to ensure no potential types were omitted. Please ignore the types which are not applicable. **Do not delete columns.**

Provide the product volume data in litres for the 2007 calendar year.

List all solvent types by replacing the "Solvent 1" label by the actual solvent name (e.g. xylene, toluene)

Try to provide solvents by specific chemical name rather than be trade name (where possible)

Provide CAS numbers where available

"Other" categories are included primarily to balance production figures - no solvent data need be given.

Division	Category	Production Volumes (Litres) for Calendar Year 2007	Total VOCs (Litres) for Calendar Year 2007
Marine	Antifouling		
Marine	Foul Release		
Marine	General		
Marine	Primer/Surfacer		
Marine	Single Pack - Protection of Steel		
Marine	Tie-Coat		
Marine	Topcoat - Multi Component		
Marine	Topcoat - One Component		
Marine	Two Pack Epoxy - Protection of Steel		
Marine	Two Pack Epoxy Filler		
Marine	Wash Primer		
Marine	Zinc Rich		
Marine	Extreme High Gloss Coating		
	TOTAL MARINE		
Yacht	Antifouling		
Yacht	Clear Wood Finish - Sealer		
Yacht	Clear Wood Finish - Varnish		
Yacht	Foul Release		
Yacht	General		
Yacht	Primer/Surfacer		
Yacht	Single Pack - Protection of Steel		
Yacht	Tie-Coat		
Yacht	Topcoat - Multi Component		
Yacht	Topcoat - One Component		
Yacht	Two Pack Epoxy - Protection of Steel		
Yacht	Two Pack Epoxy Filler		
Yacht	Wash Primer		
Yacht	Extreme High Gloss Coating		
	TOTAL YACHT		
PC	Intumescent		
PC	General		
PC	Primer/Surfacer		
PC	Single Pack - Protection of Steel		
PC	Tie-Coat		
PC	Topcoat - Multi Component		
PC	Topcoat - One Component		
PC	Two Pack Epoxy - Protection of Steel		
PC	Two Pack Epoxy Filler		
PC	Wash Primer		
PC	Zinc Rich		
	TOTAL PROTECTIVE COATINGS		
Other	Thinners		
	TOTAL ALL		

Appendix 5
Submission in respect of VOC management within the Woodcare Coatings Sector

MIROTONE

Leading the way in coating systems since 1938

MEMO

DATE: 24 September 2008

TO: Yvonne Scorgie, Environ Australia

COPY: Patrick Garofano

FROM: Don Dennis

SUBJECT: Surface Coatings - VOCs

EXECUTIVE SUMMARY

- The majority of Mirotone's industrial wood coatings are solvent based.
- Of all solvent categories, hydrocarbon solvents contribute the most to ground level ozone formation due to their high MIR value. E.g. Xylene, a very common solvent in industrial coatings, has an MIR value of 7.48 compared to n-Butyl Acetate with an MIR value of only 0.89. In other words, on an equivalent weight basis, Xylene has the potential to form more than 8 times the ground level ozone of n-Butyl Acetate.
- Aromatic free coatings typically cost more per litre than formulations that incorporate hydrocarbon solvents. The absence of any focus on MIR value in VOC target setting will maintain extensive use of hydrocarbon solvents in coating formulations.
- The weighted average MIR Value (hence ground level ozone formation potential) of Mirotone's total usage of solvents p.a. in Australia is 3.33 (purchased as solvents and as solvent content in resins).
- A 25% reduction in MIR Value over three years to a value of 2.5 should be possible.
- Mirotone's new "aromatic free" coatings launched in recent years all have MIR Values below 2.5 (MIR Values range from 0.9 to 1.9)
- Setting dual targets in terms of total VOC content (g/L) and specifying an MIR Value for the composition of the VOC content (e.g. MIR Value = 2.5 as an initial target), rather than focussing simply on an overall VOC limit without regard to solvent composition will:
  - o be much easier for industrial coating formulators to cope with than a push to achieve very low total VOC content without regard to the composition of the VOC content, and
  - o will achieve a larger and faster reduction in ground level ozone levels.

- NICNAS policy presents a very significant impediment to the adoption of new technology in Australia by blocking access to raw materials already tested and approved for use in USA and Europe. NICNAS' policy preferentially disadvantages Australian owned paint companies who base their R&D effort in Australia.

Mirotone's contribution to the Australian study of "VOCs from Surface Coatings" follows.

Consultant's Brief

Environ Australia Pty Ltd has been commissioned by the Environment Protection Heritage Council to undertake a project entitled "*Volatile Organic Compounds (VOCs) from Surface Coatings – Assessment of the Categorisation, VOC Content and Sales Volumes of Coatings Products Sold in Australia*".

The study "*is primarily concerned with VOCs that participate in atmospheric photochemical reactions*". (extracted from the "Consultant's Brief").

Maximum Incremental Reactivity (MIR) Scale

MIR is an accepted measure of the propensity of a solvent or a solvent blend to contribute to the formation of ground level ozone. This measurement system was developed by William Carter at the University of California, Riverside.

The higher the MIR value, in grams ozone per gram of VOC, the more ozone a VOC has the potential to react to form in the atmosphere.

Not all solvents contribute equally to ozone formation. Understanding this fact is critical when setting policy to achieve, in a cost effective manner, a significant reduction in ground level ozone formation.

The latest publication on MIR Values and calculations that I am aware of is titled:

DEVELOPMENT OF THE SAPRC-07 CHEMICAL MECHANISM AND UPDATED OZONE REACTIVITY SCALES

Final Report to the California Air Resources Board
Contract No. 03-318

By
William P. L. Carter
August 31, 2007

Center for Environmental Research and Technology
College of Engineering
University of California
Riverside, California 92521

Background:

Mirotone is one of the largest manufacturers in Australia of industrial surface coatings for wood and wood related substrates (including MDF, HDF, paper and synthetic foils).

Mirotone operates 3 sales divisions:

- Industrial wood and specialty coatings;
- Floor Coatings and maintenance systems; and
- Print and packaging coatings, press chemistry and consumables.

Mirotone is one of the largest privately owned, 100% Australian owned, paint companies in Australia.

The majority of the Australian paint industry is supplied by subsidiaries of foreign owned multinational paint companies – Wattyl and Haymes are exceptions to this generalisation.

Industrial wood coating division:

- Mirotone's customers are facing intense import competition. This is particularly so for imported furniture that is stained and finished with a clear topcoat. Kitchens are now also being imported (Bunnings) as are caskets and wooden window furnishings (Venetian blinds and shutters).
- Major furniture retailers import furniture directly from overseas and use this lever to extract very low prices that are unprofitable for domestic manufacturers.
- In the face of increasing import competition, Mirotone's customers seek to minimise all cost inputs, including coatings. Water based coatings are more expensive than their solvent based equivalents and require modifications to manufacturing processes to maintain fast production throughput.
- The customer base is very fragmented with only a handful of customers that spend in excess of $500K p.a. on coatings.
- The fragmented nature of the Australian wood industry, combined with the small domestic market size, makes it difficult for Australian customers to adopt high volume, automated coating application methods commonly used in Europe, USA and Asia.
- Customers seek economical, fast drying coatings with reasonable physical properties. Speed of production throughput, mainly determined by the drying time of the coatings, is very important.
- Hardly any customers are set up to apply waterborne coatings. Almost none have the infra-red (IR)/hot air drying capabilities that would be required to dry waterborne coatings in Winter and in humid conditions. Most customers would not have the available capital or production volumes to make the required investment and still remain economically viable.

Mirotone's current sales volume, across all three sales divisions is split between solvent based, water based and 100% solids UV coatings as follows:

Coating Type	% of Total Sales Volume (L)
Solvent Based	88%
Water Based	9%
UV 100% Solids (zero VOC)	3%

Most coatings sold into the print and packaging industry are either waterborne or 100% solids ultraviolet light (UV) cured coatings.

By sales division, the split of sales is as follows:

Sales Division	Solvent Based %	Waterbased + UV Cure %	% of Total Sales (L)
Industrial Wood	98%	2%	100%
Flooring	96%	4%	100%
Print/Packaging	29%	71%	100%

Trends:

Flooring (In-situ applied): Waterborne technology take-up for in-situ applied floor coatings is very strong. Mirotone's current market share of water based coatings is low. Mirotone's sales do not reflect the actual proportion of water based coatings used by floor sanders in the trade application market segment.

Print/Packaging: Waterborne and UV coating technology uptake has been very strong in this market segment for decades.

Industrial Wood: Mirotone's focus is on higher solids (lower VOC) coatings and UV cured coatings. Increasing customer interest now starting to be shown in water based technology and Mirotone is responding to this. The easiest transition for most customers is to higher solids (lower VOC) coatings because the application technique remains the same and no capital investment is required.

Mirotone's approach in this sales division has been to increase application solids where possible and reduce the MIR value (per Carter) of the solvent blends used to reduce ozone formation potential (see examples following later in this submission). In large, the MIR Value reduction has been achieved by reducing usage of aromatic hydrocarbons.

There are other market segments within industrial wood coatings that are dominated by water based technology. These areas are characterised by high volume flat panel production on roller coating lines. Companies other than Mirotone currently supply these market segments.

Total Solvent Usage

Mirotone's total solvent usage (solvents purchased plus solvents contained in resins purchased) is as follows:

Solvent Type	% of Total Volume Used p.a. (L)
Hydrocarbons	42%
Alcohols	19%
Ketones and Aldehydes	17%
Esters	16%
Glycols and Glycol Ethers	6%
Total	100%

- Mirotone formulates with 40 different solvents.
- Nine (9) solvents comprise 85% of total solvent usage (volume) p.a.
- The MIR Value of Mirotone's total solvent mix is 3.33

Usage Trend

- The trend at Mirotone has been to reduce usage of hydrocarbon solvents.
- Why?
  - Environment: Increased focus on reducing ozone formation
  - OH&S: Formulating away from toluene due to:
    - Increased scrutiny on toluene in retail/DIY products in Europe

The following points are added to Annex I of Directive 76/769/EEC:	
'48. Toluene CAS No 108-88-3	May not be placed on the market or used as a substance or constituent of preparations in a concentration equal to or higher than 0,1 % by mass in adhesives and spray paints intended for sale to the general public.

    - Low permitted TWA exposure limit of 50 ppm.
    - Central nervous system damage if applied in poorly ventilated areas.
  - The higher price of crude oil has flowed through to hydrocarbon solvent prices, although hydrocarbon solvents still have a cost advantage on a price per litre basis (although not necessarily a cost advantage on an applied coating cost per square metre due to low solvency characteristic of hydrocarbons in many resins systems).
  - The low solvency characteristic of hydrocarbon solvents in many resins systems necessitates the use of other more active solvents in order to achieve the high solids (lower VOC) objective.

Formulation Innovations to Reduce Ozone Formation Potential

Illustrated below are real examples that illustrate the benefits that may be derived from re-formulating coatings.

PRODUCT	VOC Content g/L	(Decrease) or Increase in VOC g/L	(Decrease) or Increase in VOC %	MIR Value	(Decrease) or Increase in MIR Value %
Lacquer Thinner (Traditional formulation with high volume sales)	**848**			3.4	
Lacquer Thinner (**New** Product launched in Sept 2006 with sales equal to traditional thinner)	**807**	(41)	(4.9%)	**1.9**	(44.9%)
Fast Drying Sealer for in-situ application to timber floors (Traditional formulation with high volume sales)	**732**			2.5	
Fast Drying Sealer for in-situ application to timber floors (**New** product launched in May 2007)	**798**	66	9.1%	**0.9**	(65.7%)
Clear Pre-catalysed NC Lacquer (Traditional product with highest volume sales in Australia)	**669**			2.3	
Clear Pre-catalysed NC lacquer (New product launched in July 2008)	**606**	(63)	(9.5%)	**1.7**	(25.1%)
White Universal NC Undercoat for Wood (traditional formulation)	**589**			2.3	
White Universal NC Undercoat for Wood (**New** formulation launched in June 2007)	**598**	9	1.5%	**1.3**	(41.2%)
White Polyester Undercoat for Wood Part A (launched in April 2007). High solids, low VOC with very low MIR value. This product is typically thinned 20% with low MIR solvents like acetone and MEK.	**237**			**2.1**	
Satin Clear Acid Catalysed Topcoat Part A for furniture (Traditional formula – best seller.)	**492**			4.9	
Satin Clear Acid Catalysed Topcoat Part A (**New** product launched in Dec 2003)	**521**	29	6.0%	**1.6**	(67.8%)
Gloss White Polyurethane Topcoat – Best seller for interior wood (e.g. kitchens)	**464**			4.1	
Gloss White Polyurethane Topcoat (**New** formula to be launched in October 2008)	**470**	5	1.1%	**1.3**	(68.6%)
Clear Moisture Cure Gloss Coating for interior timber floors at “Ready For Use” application viscosity (No. 1 selling product in Australia)	**519**			6.6	
Clear Moisture Cure Gloss Coating for interior timber floors (**New** high solids, low “Ready For Use” viscosity product launched in July 2008)	**303**	(216)	**(41.6%)**	6.9	5.0%

Notes:

1. It can be seen from the previous table that very significant reductions in MIR Values (hence potential to form ground level ozone) is possible. Reductions in MIR Values that Mirotone has achieved to date range from 25% to 69%.

2. The new low MIR Value formulations were achieved with total VOC levels (g/L) being maintained within +/- 10% of the original high MIR Value formulation level.

3. Moisture curing polyurethanes are very sensitive to moisture content hence hydrocarbon solvents (not water miscible) are a very good formulating choice. In the first instance Mirotone has focussed on reducing total VOC content for this product and has achieved a 42% reduction in total VOC content. The next step planned is to reduce the MIR value of our new, high solids formulation to achieve an even better environmental and OH&S outcome.

4. As a generalisation, it is far easier to change a solvent blend without reducing total VOC content (and achieve a very significant reduction in MIR value) than it is to reduce total VOC content.

5. Less formulation testing is required with a solvent composition change (without reducing total VOC content) than is required if total VOC content needs to be reduced and the formulation therefore needs to be extensively reformulated in terms of resins, pigments and additives plus solvents. Provided a new solvent blend is compatible with the resins and additives in the original high MIR Value formulation and the product still applies well to produce an attractive, protective film, the final film deposited on the substrate, after solvent evaporation, remains the same for a low MIR Value solvent blend as for the previous high MIR value formulation: physical properties of the coating therefore do not require extensive re-evaluation.

6. All of Mirotone's new formulations have an MIR value below 2.5 with a range of 0.9 to 1.9.

Ground Level Ozone Reduction Targets

The MIR Value of Mirotone's total solvent usage at present is 3.33.

A 25% reduction in MIR value would give Mirotone an MIR value of 2.5. Given adequate phase in time, an overall MIR value of 2.5 should be quite achievable.

Three years is a reasonable time period in which to achieve a 25% reduction in ground level ozone formation (ie reduction in overall MIR value of solvent blends) with a target overall MIR value within this time period of 2.5. This approach will achieve a significant reduction in ground level ozone while not destroying local industry or shifting production offshore.

Setting dual targets in terms of total VOC content and specifying an MIR Value for the composition of the VOC content (e.g. MIR Value = 2.5 as an initial target) will:

- be much easier for industrial coating formulators to cope with than a push to achieve very low total VOC content without regard to the composition of the VOC content, and
- will achieve a larger and faster reduction in ground level ozone levels.

Mirotone is also developing waterborne wood coating technology and more customers are converting across to 100% solids (zero VOC) and high solids UV cured coatings. The actual reduction in ground level ozone formation will therefore be greater than 25% due to:

- Introduction of higher solids, lower VOC coatings;
- Increased, but gradual, adoption of waterborne technology spurred on by public awareness of climate change, and other lobby groups.

Barrier to Innovation – NICNAS

NICNAS presents a huge and constant barrier to innovation for Australian headquartered paint companies. Without any exaggeration, every month, with nearly every supplier, new raw materials are unavailable to Mirotone because of lack of Australian Inventory of Chemical Substances (AICS) registration (managed by NICNAS).

I stress that the major barrier is for Australian headquartered companies like Mirotone (with its R&D function based in Sydney) because foreign owned multinational companies can import finished products into Australia that contain all the latest raw materials and additives that are unavailable to Mirotone. Most multinational companies who import are probably unaware of the formulations of many of the products they import. It is not technically feasible for any Australian authority to check the ingredients contained within imported coatings – particularly additives that are contained in very small proportion of the total paint formula but are vital for their good performance.

I cannot understand why raw materials that have been tested and approved for use in the USA and Europe are not automatically approved for use within Australia. The Australian market is far too small to re-test every raw material that has already been extensively tested and overseas. The cost of re-testing is a non-value added burden on industry.

Raw material suppliers in Australia, many of whom are agents for overseas principals, are extremely reluctant to invest the time and money to gain Australian registration for new raw materials where demand levels are not high (or are unknown hence a "catch-22" situation). Additives, typically used in fractions of a percent and almost always at less than 5% of formulas, are difficult to gain access to because potential sales volume in Australia is low.

Mirotone's most recent bad experience due to NICNAS occurred last week. A catalyst recommended to Mirotone in a supplier starting point formula for a two component water based product is not registered in AICS for sales in Australia. My correspondence (edited to maintain confidentiality) is reproduced below (read from the bottom up).

“From: Don Dennis
Sent: Friday, 19 September 2008 1:46 PM
To: 'SUPPLIER'
Subject: RE: [RAW MATERIAL NAME]

XX,

A forecast is very difficult to provide. The starting point formulation requires well under 1% of the [raw material name]. The formulation we are considering is new and as yet untested in our target market. We are at the stage of making up lab samples and testing in tech service. My crystal ball is hazy on this product. Sometimes products that I believe will sell well fade into oblivion and others surprise me with the rapidity of sales growth. At best we are talking hundreds of litres p.a. rather than tonnes.

Regards,
Don

From: [mailto:SUPPLIER]
Sent: Friday, 19 September 2008 10:05 AM
To: Don Dennis
Cc: XXX; Patrick Garofano
Subject: RE: [RAW MATERIAL NAME]

Hi Don
As it turns out a NZ notification is not as easy as I thought. We would have to do a full notification and as the US do not have all the data required it may take a little time.
An Australian registration would probably cost $10,000 plus.
We use [XXX] as a distributor in NZ so I will ask them what they think it would cost there.
Do you have any idea of the qty you might use in a year if successful? “

The email exchange above is very typical. It is very frustrating. It penalises Australian based companies that manufacture locally and conduct research and development within Australia.

Mirotone wants to do the right thing by the environment and for human health but is blocked, by NICNAS policy, from using many of the latest raw materials, approved for use in the USA and Europe, that would facilitate the formulation of high solids (low VOC) or waterborne coatings.

The first question I ask every raw material supplier is “Is the raw material registered on AICS?” Invariably, new raw materials (most likely already used by Mirotone’s global competitors and likely imported into Australia as components of paint) are not.

Don Dennis
Group Managing Director
Mirotone Pty Ltd

Appendix 6
Reactivity Values for VOCs Applied in the Study

CAS	Compound	Reactivity, MIR (g O3 / g VOC)	Vapour Pressure (mmHg)	Boiling Point (℃)
100-41-4	ethyl benzene	2.95	9.6	136.1
100-42-5	styrene	1.65	6.4	145
100-51-6	benzyl alcohol	5.01	0.094	205.3
103-65-1	n-propyl benzene	1.96	3.42	159.2
107-98-2	1-methoxy-2-propanol	2.34	12.5	119
108-01-0	dimethylaminoethanol	5.44	3.18	134
108-10-1	4-methyl-2-pentanone	3.76	19.9	116.5
108-10-1	4-methyl-2-pentanone	3.76	19.9	116.5
108-65-6	1-methoxy-2-propyl acetate	1.63	3.92	145.5
108-67-8	1,3,5-trimethyl benzene	11.50	2.48	164.7
108-88-3	toluene	3.90	28.4	110.6
108-94-1	cyclohexanone	1.27	4.33	155.4
110-12-3	5-methyl-2-hexanone	2.29	5.77	144
110-19-0	isobutyl acetate	0.59	17.8	116.5
110-43-0	2-heptanone	2.25	3.86	151
111-76-2	2-butoxyethanol	2.79	0.88	168.4
112-07-2	2-butoxyethyl acetate	1.54	0.375	192
112-34-5	2-(2-butoxyethoxy)-ethanol	2.27	0.0219	231
119-64-2	tetralin	2.87	0.368	207.6
123-42-2	diacetone alcohol	0.57	1.71	167.9
123-86-4	n-butyl acetate	0.79	11.5	126.1
127519-17-9	hydroxxyphenyl-alkylbenzotriazole	ND	ND	ND
1330-20-7	C8 disubstituted benzenes	7.61	7.99	138.5
13588-28-8	dipropylene glycol methyl ether isomer	2.47	ND	ND
138-86-3	dipentene	3.99	1.55	176
141-78-6	ethyl acetate	0.60	93.2	77.1
1569-02-4	1-ethoxy-2-propanol	2.97	ND	131
26761-45-5	neodecanoic acid glycidyl ester	8.36	ND	ND
34590-94-8	methoxypropoxypropanol	2.21	0.55	188.3
41556-26-7	bis-(1,2,2,6,6-pentamethyl-4-piperidinyl)-sebacate	ND	ND	ND
5131-66-8	n-butoxy-2-propanol (propylene glycol n-butyl ether)	2.60	ND	171.5
54839-24-6	ethoxy propyl acetate	ND	ND	ND
56539-66-3	3 methoxy -3 methyl-butanol	1.47	ND	ND
57-55-6	propylene glycol	2.49	0.129	187.6
624-54-4	n-pentyl propionate	0.66	3.6	168.6
627-93-0	dimethyl adipate	1.73	0.0604	115
64-17-5	ethanol	1.46	59.3	78.2
64-19-7	acetic acid	0.67	15.7	117.9
64741-69-1	naphtha (petroleum) , light	4.18	ND	ND

CAS	Compound	Reactivity, MIR (g O3 / g VOC)	Vapour Pressure (mmHg)	Boiling Point (℃)
	hydrocracked			
64742-94-5	R150 (Shellsol A150)	8.1	ND	ND
64742-94-5	Solvent naphtha (petroleum), heavy aromatic	5.72	ND	ND
64742-95-6	R100 (Shellsol A100)	7.5	ND	ND
64742-95-6	solvent naphtha (petroleum) , light aromatic	4.18	ND	ND
64742-95-6	Solvesso 100	7.5	ND	ND
64742-95-6	solvent naphtha (petroleum) , light aromatic	4.18	ND	ND
67-63-0	isopropyl alcohol	0.59	45.4	82.3
67-64-1	acetone	0.35	232	56
71-23-8	n-propyl alcohol	2.40	21	97.2
71-36-3	n-butyl alcohol	2.77	6.7	117.7
71-41-0	pentyl alcohol	2.72	2.2	137.9
763-69-9	ethyl 3-ethoxy propionate	3.48	ND	ND
7705-14-8	Dipentene 300	3.99	ND	178
7779-90-0	trizincbis (orthophosphate)	ND	ND	ND
78-59-1	isophorone {3,5,5-trimethyl-2-cyclohexenone}	4.50	0.438	215.2
78-83-1	isobutyl alcohol	2.42	10.5	107.8
78-92-2	s-butyl alcohol	1.30	18.3	99.5
78-93-3	methyl ethyl ketone	1.44	90.6	79.5
8052-41-3	White spirits	2	ND	ND
82919-37-7	methyl 1,2,2,6,6, pentamethyl-4-piperrridyl sebacate	ND	ND	ND
872-50-4	n-methyl-2-pyrrolidone	2.29	0.345	202
95-63-6	1,2,4-trimethyl benzene	8.69	2.1	169.3
98-00-0	Furfuryl alcohol	7.04	0.609	171
98-82-8	isopropyl benzene (cumene)	2.44	4.5	152.4
	Regular mineral spirits	1.74		
	VMP Naphtha	1.13		
	mineral turps	3.8		
	shell X3B	2.8		
	shell X55	1.6		
	Exxsol D30	0.55		
	SBP 100/140	1.28		
	SBP 80/100	0.88		

Appendix 7
VOC and Ozone Formation Potential Estimates for Product Types

Market Segment	Product Category	Product Type	Type	Volumes Sold (litres)	Total VOCs (tonnes)- including acetone	Ozone Created (tonnes)
Architectural & Decorative	Paints, Enamels & Clears	Paving Paint: solvent-based	solvent	895,271	446.1	1,159.9
		Roof Paint: solvent-based	solvent	70,435	28.7	74.5
		Metal finishes	solvent	1,584,825	733.4	1,906.8
		Prepcoats: solvent-based	solvent	2,618,340	1,209.1	3,143.7
		Door,Window,Trim: solvent-based	solvent	5,245,155	2,060.6	5,357.5
		Paving Paint: water-based	water	784,269	54.7	142.3
		Roof Paint: water-based	water	228,458	19.2	47.9
		Fence finishes	water	1,026,397	5.5	13.6
		Specialty finishes	water	2,292,561	209.5	521.6
		"Heavy end" texture coatings	water	31,030,511	1,069.8	2,663.9
		Prepcoats: water-based	water	12,219,810	535.7	1,333.9
		Ceiling Paint/Flat topcoats	water	17,444,227	423.5	1,054.5
		Door,Window,Trim: water-based	water	1,687,507	119.8	298.3
		Interior topcoats: water-based	water	41,283,652	1,263.4	3,145.9
		Exterior topcoats:water-based	water	23,084,081	1,055.0	2,626.9
		TOTAL		**141,495,498**	**9,233.9**	**23,491.1**

Market Segment	Product Category	Product Type	Type	Volumes Sold (litres)	Total VOCs (tonnes)- including acetone	Ozone Created (tonnes)
Architectural & Decorative (Woodcare)	Wood care	Decking Paint: water-based	low VOC	296,463	12.7	34.8
		Decking Paint: solvent-based	solvent	2,809,196	1,782.6	4,866.4
		Flooring: water-based	low VOC	99,616	11.6	31.6
		Flooring: solvent-based	solvent	599,234	336.6	919.0
		Interior Stains: water-based	low VOC	73,648	10.0	27.3
		Interior Stains: solvent-based	solvent	359,719	161.0	439.5
		Exterior Stains: water-based	low VOC	265,727	25.7	70.2
		Exterior Stains: solvent-based	solvent	268,689	172.9	472.0
		Prepcoats: water-based	low VOC	331,171	16.6	45.2
		Prepcoats: solvent-based	solvent	84,117	40.8	111.4
		Interior clears: water-based	low VOC	184,101	25.0	68.1
		Interior clears: solvent-based	solvent	650,499	292.7	799.1
		Exterior clears: water-based	low VOC	243,641	20.7	56.6
		Exterior clears: solvent based	solvent	26,181	11.1	30.3
		TOTAL		**6,292,002**	**2,920.0**	**7,971.6**

Market Segment	Product Category	Product Type	Type	Volumes Sold (litres)	Total VOCs (tonnes)- including acetone	Ozone Created (tonnes)
Industry	Road & Runway	Road & Runway Marking (water borne)	low VOC	4,019,438	82.5	120.4
		Road & Runway Marking (solvent borne)	solvent	869,889	323.9	1,092.6
		TOTAL		**4,889,328**	**406.4**	**1,213.0**
	Finishing Coats	Alkyd - solvent borne	solvent	2,049,821	736.8	2,168.2
		Polyurethane 2K - solvent borne	solvent	66,619	25.5	63.5
		Isofree 2K - solvent borne	solvent	149,893	36.8	183.9
		Epoxy - solvent borne	solvent	98,833	25.0	125.0
		Baking enamel - water borne	low VOC	584,902	103.5	378.8
		Baking enamel - solvent borne	solvent	2,365,707	1,782.0	9,171.1
		Acrylics - water borne	low VOC	464,408	25.5	71.3
		Acrylics - solvent borne	solvent	241,216	141.0	519.5
		TOTAL		**6,021,399**	**2,876.1**	**12,681.4**
	Primers & Undercoats	Alkyd 1K (water borne)	low VOC	18,297	0.2	0.3
		Alkyd 1K (solvent borne)	solvent	1,534,719	432.1	1,292.4
		Polyurethane 2K (solvent borne)	solvent	102,747	39.7	102.1
		Isofree 2K (solvent borne)	solvent	91,870	2.3	11.3
		Vinyl etch (solvent borne)	solvent	526,321	398.3	1,180.7
		Epoxy (water borne)	low VOC	5,717,143	646.0	1,800.3
		Epoxy (solvent borne)	solvent	1,133,251	636.2	1,795.3
		Acrylics (water borne)	low VOC	587,995	22.9	63.7
		Acrylics (solvent borne)	solvent	161,231	86.6	349.4
		TOTAL		**9,873,575**	**2,264.2**	**6,595.4**

Market Segment	Product Category	Product Type	Type	Volumes Sold (litres)	Total VOCs (tonnes)- including acetone	Ozone Created (tonnes)
Industry	Industrial Woodcare	Stains	solvent	489,129	377.6	1,257.3
		Clears	solvent	2,166,095	1,324.3	4,409.9
		Solid Colours	solvent	1,409,699	727.8	2,423.7
		TOTAL		**4,064,923**	**2,429.7**	**8,090.9**

Market Segment	Product Category	Product Type	Type	Volumes Sold (litres)	Total VOCs (tonnes)- including acetone	Ozone Created (tonnes)
Automotive	Refinishing	1K - Synthetic air dry enamels (Primers)	solvent	260,000	183.8	867.2
		1K - Synthetic air dry enamels (Topcoats)	solvent	290,000	205.0	967.2
		1K-Primers	solvent	684,000	632.7	1,883.5
		Plastics Adhesion Promoters	solvent	100,000	54.0	158.6
		1K-Lacquers-Clear	solvent	242,880	227.1	661.7
		1K - Lacquers- Colour Basecoat Effect	solvent	502,460	479.5	1,395.7
		1K - Lacquers - Colour Single Stage	solvent	501,490	478.4	1,392.3
		2K Etch Primer	solvent	360,000	226.7	734.8
		2K Epoxy Or Other Primer (non PU)	solvent	236,880	564.3	2,068.3
		2K - Primers - Urethane	solvent	749,000	348.2	1,612.7
		2K - Basecoats	solvent	1,987,080	1,319.8	3,422.5
		2K - Topcoats - Clears	solvent	1,240,020	536.7	1,766.0
		2K - Topcoats - Colour	solvent	1,739,450	723.1	2,434.0
		Others (e.g. Cleaners, Enamels)	solvent	488,640	362.2	673.1
		1K-Primers	low VOC	36,000	1.3	3.9
		1K-Lacquers-Clear	low VOC	10,120	0.1	0.3
		1K - Lacquers- Colour Basecoat Effect	low VOC	15,540	0.4	1.0
		1K - Lacquers - Colour Single Stage	low VOC	15,510	0.4	1.0
		2K Epoxy Or Other Primer (non PU)	low VOC	45,120	3.1	11.1
		2K - Basecoats	low VOC	296,920	3.9	11.7
		2K - Topcoats - Clears	low VOC	253,980	5.9	19.4
		2K - Topcoats - Colour	low VOC	91,550	0.8	2.8
		Others (e.g. Cleaners, Enamels)	low VOC	20,360	0.4	0.7
		TOTAL		**10,167,000**	**6,358**	**20,089**

Market Segment	Product Category	Product Type	Type	Volumes Sold (litres)	Total VOCs (tonnes)- including acetone	Ozone Created (tonnes)
Heavy Duty & Marine	Marine	Antifouling	Solvent	364,988	167.9	512.3
		Foul Release	Solvent			
		General	Mixed	8,060	1.9	2.2
		Primer/Surfacer	Solvent	70,785	25.4	86.7
		Single Pack - Protection of Steel	Solvent	19,021	9.3	36.1
		Tie-Coat	Solvent	100,138	38.7	112.3
		Topcoat - Multi Component	Solvent	120,403	44.0	164.8
		Topcoat - One Component	Solvent	108,365	46.0	182.3
		Two Pack Epoxy - Protection of Steel	Solvent	201,068	48.5	162.1
		Two Pack Epoxy Filler	Mixed	467	0.1	0.4
		Wash Primer	Solvent	794	0.6	1.7
		Zinc Rich	Solvent	16,633	7.3	22.9
		Extreme High Gloss Coating	Solvent	1,046	0.5	1.5
		TOTAL		**1,011,768**	**390.1**	**1,285.2**

Market Segment	Product Category	Product Type	Type	Volumes Sold (litres)	Total VOCs (tonnes)- including acetone	Ozone Created (tonnes)
Heavy Duty & Marine	Yacht	Antifouling	Solvent	207,513	72.6	287.7
		Clear Wood Finish - Sealer	Solvent	19,849	14.8	54.2
		Clear Wood Finish - Varnish	Solvent	19,835	10.0	39.1
		Foul Release	Solvent			
		General	Mixed	39,411	3.2	6.3
		Primer/Surfacer	Solvent	186,965	48.6	130.6
		Single Pack - Protection of Steel	Solvent	7,450	3.6	14.0
		Tie-Coat	Solvent	20,636	9.6	26.4
		Topcoat - Multi Component	Solvent	17,997	7.0	24.3
		Topcoat - One Component	Solvent	19,560	6.6	25.8
		Two Pack Epoxy - Protection of Steel	Solvent	4,784	1.4	4.9
		Two Pack Epoxy Filler	Solvent	16,282	3.0	9.6
		Wash Primer	Solvent	38,983	31.4	82.1
		Extreme High Gloss Coating	Solvent	53,519	24.0	74.9
		TOTAL		**652,785**	**235.8**	**780.0**

Market Segment	Product Category	Product Type	Type	Volumes Sold (litres)	Total VOCs (tonnes)- including acetone	Ozone Created (tonnes)
Heavy Duty & Marine	Protective Coatings	Intumescent				
		General	Mixed	58,143	16.8	7.7
		Primer/Surfacer	Solvent	1,066,455	421.6	1,486.4
		Single Pack - Protection of Steel	Solvent	617,269	259.5	1,019.0
		Tie-Coat	Solvent	69,045	21.9	52.4
		Topcoat - Multi Component	Solvent	1,655,952	633.2	2,394.0
		Topcoat - One Component	Solvent	717,627	348.0	1,379.3
		Two Pack Epoxy - Protection of Steel	Solvent	4,165,452	741.3	2,207.6
		Two Pack Epoxy Filler	Solvent	47,082	9.8	30.8
		Wash Primer	Solvent	3,286	2.7	9.5
		Zinc Rich	Solvent	1,516,073	507.1	1,214.1
		TOTAL		**9,916,383**	**2,961.9**	**9,800.8**
	Other	Thinners	Solvent	1,650,404	1,650.6	3,976.2

Market Segment	Product Category	Product Type	Type	Solvent Content (g/L) Max	Solvent Content (g/L) Volume-weighted Average	Solvent Content (g/L) Min	Ozone Creation Potential (g/L) Max	Ozone Creation Potential (g/L) Volume-weighted Average	Ozone Creation Potential (g/L) Min	MIR Value Max	MIR Value Volume-weighted Average	MIR Value Min	No. Companies
Architectural & Decorative	Paints, Enamels & Clears	Paving Paint: solvent-based	solvent	524	498	429	1,364	1,296	1,115	2.60	2.60	2.60	6
		Roof Paint: solvent-based	solvent	465	407	388	1,208	1,058	1,009	2.60	2.60	2.60	5
		Metal finishes	solvent	492	463	367	1,278	1,203	953	2.60	2.60	2.60	6
		Prepcoats: solvent-based	solvent	574	462	360	1,493	1,201	936	2.60	2.60	2.60	6
		Door,Window,Trim: solvent-based	solvent	411	393	382	1,069	1,021	994	2.60	2.60	2.60	6
		Paving Paint: water-based	water	82	70	21	212	181	55	2.60	2.60	2.60	6
		Roof Paint: water-based	water	88	84	12	219	210	31	2.49	2.49	2.49	6
		Fence finishes	water	20	5	0	49	13	1	2.49	2.49	2.49	6
		Specialty finishes	water	219	91	50	544	228	124	2.49	2.49	2.49	6
		"Heavy end" texture coatings	water	56	34	29	139	86	71	2.49	2.49	2.49	6
		Prepcoats: water-based	water	56	44	23	140	109	58	2.49	2.49	2.49	6
		Ceiling Paint/Flat topcoats	water	60	24	5	149	60	12	2.49	2.49	2.49	6
		Door,Window,Trim: water-based	water	75	71	42	187	177	104	2.49	2.49	2.49	6
		Interior topcoats: water-based	water	58	31	17	145	76	42	2.49	2.49	2.49	6
		Exterior topcoats:water-based	water	60	46	34	150	114	85	2.49	2.49	2.49	6
		TOTAL			**65**			**166**			**2.54**		
Architectural & Decorative (Woodcare)	Wood care	Decking Paint: water-based	low VOC		43			117			2.73		
		Decking Paint: solvent-based	solvent		635			1,732			2.73		
		Flooring: water-based	low VOC		116			317			2.73		
		Flooring: solvent-based	solvent		562			1,534			2.73		
		Interior Stains: water-based	low VOC		136			370			2.73		
		Interior Stains: solvent-based	solvent		448			1,222			2.73		
		Exterior Stains: water-based	low VOC		97			264			2.73		
		Exterior Stains: solvent-based	solvent		643			1,757			2.73		
		Prepcoats: water-based	low VOC		50			137			2.73		
		Prepcoats: solvent-based	solvent		485			1,325			2.73		
		Interior clears: water-based	low VOC		136			370			2.73		
		Interior clears: solvent-based	solvent		450			1,229			2.73		
		Exterior clears: water-based	low VOC		85			232			2.73		
		Exterior clears: solvent based	solvent		425			1,159			2.73		
		TOTAL			**464**			**1,267**			**2.73**		

Market Segment	Product Category	Product Type	Type	Solvent Content (g/L)			Ozone Creation Potential (g/L)			MIR Value			No. Companies
				Max	Volume-weighted Average	Min	Max	Volume-weighted Average	Min	Max	Volume-weighted Average	Min	
Industry	Road & Runway	Road & Runway Marking (water borne)	low VOC	22	21	20	32	30	29	1.46	1.46	1.50	2
		Road & Runway Marking (solvent borne)	solvent	523	372	331	3,295	1,256	697	6.30	3.37	2.10	2
		TOTAL			**83**			**248**			**2.98**		
	Finishing Coats	Alkyd - solvent borne	solvent	659	359	311	4,158	1,058	929	6.31	2.94	2.91	3
		Polyurethane 2K - solvent borne	solvent	521	382	262	2,087	953	756	4.01	2.49	1.62	3
		Isofree 2K - solvent borne	solvent	246	246	246	1,227	1,227	1,227	5.00	5.00	5.00	1
		Epoxy - solvent borne	solvent	580	253	246	2,996	1,265	1,227	5.17	5.01	5.00	2
		Baking enamel - water borne	low VOC	177	177	177	648	648	648	3.66	3.66	3.66	1
		Baking enamel - solvent borne	solvent	774	753	412	4,043	3,877	1,144	5.22	5.15	2.78	2
		Acrylics - water borne	low VOC	55	55	55	154	154	154	2.79	2.79	2.79	1
		Acrylics - solvent borne	solvent	589	585	537	2,167	2,154	2,152	4.04	3.68	3.65	2
		TOTAL			**478**			**2,106**			**4.41**		
	Primers & Undercoats	Alkyd 1K (water borne)	low VOC	8	8	8	17	17	17	2.05	2.05	2.05	1.0
		Alkyd 1K (solvent borne)	solvent	463	282	31	1,385	842	93	2.99	2.99	2.98	2.0
		Polyurethane 2K (solvent borne)	solvent	555	386	26	1,324	994	79	3.03	2.57	2.02	3.0
		Isofree 2K (solvent borne)	solvent	25	25	25	123	123	123	5.00	5.00	5.00	1.0
		Vinyl etch (solvent borne)	solvent	758	757	640	3,747	2,243	2,229	5.85	2.96	2.94	2.0
		Epoxy (water borne)	low VOC	113	113	113	315	315	315	2.79	2.79	2.79	1.0
		Epoxy (solvent borne)	solvent	646	561	25	2,515	1,584	123	5.00	2.82	2.68	3.0
		Acrylics (water borne)	low VOC	108	39	1	284	108	3	2.79	2.79	2.63	3.0
		Acrylics (solvent borne)	solvent	537	537	537	2,167	2,167	2,167	4.04	4.04	4.04	1.0
		TOTAL			**229**			**668**			**2.91**		
	Industrial Woodcare	Stains	solvent		772			2,571			3.33		
		Clears	solvent		611			2,036			3.33		
		Solid Colours	solvent		516			1,719			3.33		
		TOTAL			**598**			**1,990**			**3.33**		

Market Segment	Product Category	Product Type	Type	Solvent Content (g/L)			Ozone Creation Potential (g/L)			MIR Value			No. Companies
				Max	Volume-weighted Average	Min	Max	Volume-weighted Average	Min	Max	Volume-weighted Average	Min	
Automotive	Refinishing	1K - Synthetic air dry enamels (Primers)	solvent		707			3,335			4.72		3-6
		1K - Synthetic air dry enamels (Topcoats)	solvent		707			3,335			4.72		3-6
		1K-Primers	solvent		925			2,754			2.98		3-6
		Plastics Adhesion Promoters	solvent		540			1,586			2.94		3-6
		1K-Lacquers-Clear	solvent		935			2,724			2.91		3-6
		1K - Lacquers- Colour Basecoat Effect	solvent		954			2,778			2.91		3-6
		1K - Lacquers - Colour Single Stage	solvent		954			2,776			2.91		3-6
		2K Etch Primer	solvent		630			2,041			3.24		3-6
		2K Epoxy Or Other Primer (non PU)	solvent		2,382			8,731			3.66		3-6
		2K - Primers - Urethane	solvent		465			2,153			4.63		3-6
		2K - Basecoats	solvent		664			1,722			2.59		3-6
		2K - Topcoats - Clears	solvent		433			1,424			3.29		3-6
		2K - Topcoats - Colour	solvent		416			1,399			3.37		3-6
		Others (e.g. Cleaners, Enamels)	solvent		741			1,377			1.86		3-6
		1K-Primers	low VOC		37			109			2.94		3-6
		1K-Lacquers-Clear	low VOC		12			33			2.68		3-6
		1K - Lacquers- Colour Basecoat Effect	low VOC		23			62			2.69		3-6
		1K - Lacquers - Colour Single Stage	low VOC		23			62			2.69		3-6
		2K Epoxy Or Other Primer (non PU)	low VOC		68			246			3.63		3-6
		2K - Basecoats	low VOC		13			39			2.97		3-6
		2K - Topcoats - Clears	low VOC		23			76			3.30		3-6
		2K - Topcoats - Colour	low VOC		9			30			3.36		3-6
		Others (e.g. Cleaners, Enamels)	low VOC		18			34			1.86		3-6
		TOTAL			**625**			**1,976**			**3.16**		

Market Segment	Product Category	Product Type	Type	Solvent Content (g/L)			Ozone Creation Potential (g/L)			MIR Value			No. Companies
				Max	Volume-weighted Average	Min	Max	Volume-weighted Average	Min	Max	Volume-weighted Average	Min	
Heavy Duty	Marine	Antifouling	Solvent	540	460	279	1,648	1,404	852		3.05		3
		Foul Release	Solvent										0
		General	Mixed	612	232	216	706	267	249		1.15		2
		Primer/Surfacer	Solvent	461	358	342	1,575	1,225	1,170		3.42		2
		Single Pack - Protection of Steel	Solvent	504	488	487	1,961	1,897	1,895		3.89		2
		Tie-Coat	Solvent	544	386	299	1,581	1,121	868		2.91		3
		Topcoat - Multi Component	Solvent	598	366	317	2,239	1,369	1,187		3.74		2
		Topcoat - One Component	Solvent	642	424	396	2,545	1,682	1,568		3.96		3
		Two Pack Epoxy - Protection of Steel	Solvent	499	241	240	1,669	806	801		3.34		2
		Two Pack Epoxy Filler	Mixed	326	264	107	1,005	815	332		3.09		2
		Wash Primer	Solvent	796	796	796	2,080	2,080	2,080		2.61		1
		Zinc Rich	Solvent	572	437	204	1,808	1,380	645		3.16		2
		Extreme High Gloss Coating	Solvent	618	451	437	1,929	1,408	1,365		3.12		2
		TOTAL			**386**			**1,270**			**3.29**		**3**
	Yacht	Antifouling	Solvent	570	350	295	2,259	1,387	1,169		3.96		4
		Clear Wood Finish - Sealer	Solvent	744	744	744	2,733	2,733	2,733		3.67		1
		Clear Wood Finish - Varnish	Solvent	624	506	435	2,428	1,969	1,694		3.89		3
		Foul Release	Solvent										0
		General	Mixed	616	82	79	1,205	161	154		1.96		2
		Primer/Surfacer	Solvent	616	260	258	1,655	699	694		2.69		3
		Single Pack - Protection of Steel	Solvent	490	489	318	1,890	1,883	1,224		3.85		2
		Tie-Coat	Solvent	537	463	301	1,480	1,279	830		2.76		4
		Topcoat - Multi Component	Solvent	566	387	378	1,973	1,351	1,317		3.49		2
		Topcoat - One Component	Solvent	432	337	333	1,696	1,321	1,306		3.93		2
		Two Pack Epoxy - Protection of Steel	Solvent	309	303	264	1,046	1,023	892		3.38		2
		Two Pack Epoxy Filler	Solvent	182	182	182	589	589	589		3.23		1
		Wash Primer	Solvent	900	806	791	2,353	2,105	2,067		2.61		2
		Extreme High Gloss Coating	Solvent	448	448	448	1,399	1,399	1,399		3.12		1
		TOTAL			**361**			**1,195**			**3.31**		4
	Protective Coatings	Intumescent											0
		General	Mixed	493	289	5	226	133	2		0.46		3
		Primer/Surfacer	Solvent	612	395	343	2,158	1,394	1,209		3.53		4
		Single Pack - Protection of Steel	Solvent	493	420	295	1,936	1,651	1,158		3.93		4
		Tie-Coat	Solvent	522	317	294	1,250	759	705		2.39		2
		Topcoat - Multi Component	Solvent	566	382	312	2,138	1,446	1,179		3.78		4
		Topcoat - One Component	Solvent	522	485	300	2,069	1,922	1,188		3.96		4
		Two Pack Epoxy - Protection of Steel	Solvent	522	178	147	1,555	530	437		2.98		4
		Two Pack Epoxy Filler	Solvent	322	207	97	1,018	655	305		3.16		3
		Wash Primer	Solvent	834	834	834	2,880	2,880	2,880		3.45		1
		Zinc Rich	Solvent	624	335	229	1,494	801	549		2.39		4
		TOTAL			**299**			**988**			**3.31**		**4**
	Other	Thinners	Solvent	1,021	1,000	922	2,459	2,409	2,220		2.41		2

Appendix 8
APAS VOC Limits

APAS VOC Limits given in g/litre

High Volume Architectural Products		Average	Max
0134	Latex primer for galvanised iron & Zincalume	45	50
0.163/1	Exterior latex undercoat	55	65
0163/2	Interior latex undercoat	60	65
0172	Interior sealer	50	60
0183	Exterior timber primer	50	60
0260/1	Interior gloss	75	90
0260/2	Interior semi gloss	65	80
0260/3	Interior low sheen	50	75
0260/4	Interior flat - washable	60	70
0260/5	Interior flat - ceilings	50	60
0280/1	Exterior gloss	60	85
0280/2	Exterior semi gloss	60	80
0280/3	Exterior flat & low sheen	45	70
0280/4	Exterior gloss	65	80
0280/5	Exterior low sheen	50	80

Other Architectural Products		Max
0011	Solvent borne roof paint for galvanised steel	450
0012	Latex roof paint	100
0015	Exterior/interior alkyd, gloss & semi gloss	450
0016	Interior & exterior undercoat	450
0024	Exterior oil & petrol residtant enamel	450
0029	Undercoat (oil & petrol resistant)	450
0032	Metal primer (buildings - exlucing lead & chromates)	550
0055	One pack exterior varnish (general purpose)	550
0070/1	Chalkboard paint - solvent based	450
0070/3	Chalkboard paint - water based	100
0114	One pack interior varnish (general purpose)	500
0115	Lightly pigmented ranch finish - exterior timber	450
0162	Zinc phosphate metal primer	550
0171	Interior solvent based sealer	450
0181	Primer	450
0200	One pack pigmented solvent borne paving paint	550
0202	One pack pigmented latex paving paint	80
0215	Low odour/low environmental impact	5

Industrial & Protective Coating Products		Max
0006	Army olive drab enamel	550
0009	Undercoart for Army Olive Drab flat enamel	550
0041/2	Road marking paint - solvent borne	450
0041/5	Road marking paint - while water borne	60
2901	Protective coatings for steel - latex	100
2920	Polysilozane coating	400
2921	Protective coatings for steel - primers	450
2922	Protective coatings for steel - modified alkyd finish	450
2930	Single pack moisture cure urethane for steel	400
2940	MIO or aluminium coating subject to continuous condensation	350
2971	Epoxy primers, 2 pack	400
2972	Low build epoxy GP enamel, 2 pack	350
2973	Solvent borne epoxy to 400 µm, 2 pack	350
2974	Solventless epoxy to 400 µm, 2 pack	120
2975	Ultra high build epoxy, immersion, 2 pack	350
2976	Solvent borne epoxy mastic	180
2977	Solvent borne epoxy mastic, slow drying; high volume solids; >400 µm	180

Appendix 9
EC VOC Limits for Surface Coatings

ANNEX II

A. **MAXIMUM VOC CONTENT LIMIT VALUES FOR PAINTS AND VARNISHES**

	Product Subcategory	Type	Phase I (g/l (*)) (from 1.1.2007)	Phase II (g/l (*)) (from 1.1.2010)
a	Interior matt walls and ceilings (Gloss <25@60°)	WB	75	30
		SB	400	30
b	Interior glossy walls and ceilings (Gloss >25@60°)	WB	150	100
		SB	400	100
c	Exterior walls of mineral substrate	WB	75	40
		SB	450	430
d	Interior/exterior trim and cladding paints for wood and metal	WB	150	130
		SB	400	300
e	Interior/exterior trim varnishes and woodstains, including opaque woodstains	WB	150	130
		SB	500	400
f	Interior and exterior minimal build woodstains	WB	150	130
		SB	700	700
g	Primers	WB	50	30
		SB	450	350
h	Binding primers	WB	50	30
		SB	750	750
i	One-pack performance coatings	WB	140	140
		SB	600	500
j	Two-pack reactive performance coatings for specific end use such as floors	WB	140	140
		SB	550	500
k	Multi-coloured coatings	WB	150	100
		SB	400	100
l	Decorative effect coatings	WB	300	200
		SB	500	200

(*) g/l ready to use

B. **MAXIMUM VOC CONTENT LIMIT VALUES FOR VEHICLE REFINISHING PRODUCTS**

	Product Subcategory	Coatings	VOC g/l (*) (1.1.2007)
a	Preparatory and cleaning	Preparatory	850
		Pre-cleaner	200
b	Bodyfiller/stopper	All types	250
c	Primer	Surfacer/filler and general (metal) primer	540
		Wash primer	780
d	Topcoat	All types	420
e	Special finishes	All types	840

(*) g/l of ready for use product. Except for subcategory (a) any water content of the product ready for use should be discounted.

Appendix 10
California Air Resources Board (CARB) VOC Limits for Automotive Refinishing Coatings

Coating Category	VOC regulatory limit, as applied	
	Effective 1 January 2009 (grams/litre)	Effective 1 January 2010 (grams/litre)
Adhesion promoter		540
Clear coating	250	
Color coating	420	
Multi-color coating	680	
Pretreatment coating	660	
Primer	250	
Primer sealer		250
Single-stage coating		340
Temporary protective coating	60	
Truck bed liner coating	310	
Underbody coating	430	
Uniform finish coating	540	
Any other coating type	250	