

ESD - COATINGS & VOC

INTRODUCTION

According to the Green Building Council of Australia, commercial buildings contribute 8.8% of the national greenhouse emissions in this country (which is high by world standards). Designing more ecologically sustainable commercial buildings is one way to reduce our contribution to greenhouse emissions.ⁱ

The issue of VOC is extremely complex; to illustrate this complexity, below are a few issues associated with VOC's, coating choice, and how coating choice impacts on our environment.

WHAT IS VOC?

VOC stands for Volatile Organic Component, or Volatile Organic Compound. The term includes both naturally occurring and man-made compounds. The term "organic" means carbon-based.

The definition of VOC, when related to paints and coatings, is described in the APAS (Australian Paint Approval Scheme) Document No. 181ⁱⁱ. In that document, a VOC is an organic compound with a boiling point less than 250°C at one standard atmosphere pressure (101325 Pa) or a vapour pressure less than 0.01mm Hg at 21°C.

IS VOC THE SAME AS HAP?

No, these are different. HAP stands for Hazardous Air Pollutant.

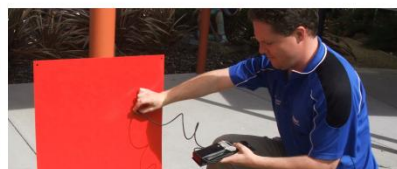
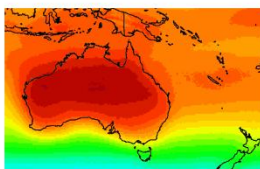
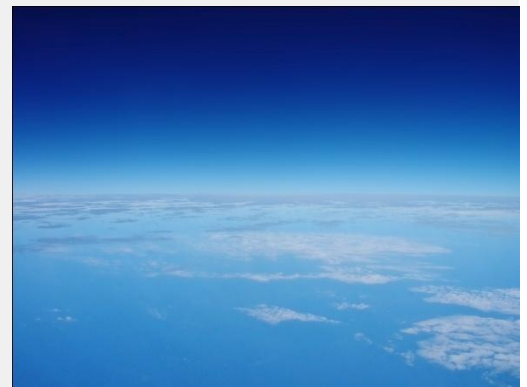
According to the US EPA, six common air pollutants (also known as "criteria pollutants") are found all over the United States. They are particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulphur oxides, nitrogen oxides, and lead. These pollutants can harm your health and the environment, and cause property damage. Of the six pollutants, **particle pollution** and **ground-level ozone** are the most widespread health threats.ⁱⁱⁱ

Whilst HAPs do occur in nature (for example, volcanic eruptions), most HAPs are released into the environment by industrial activity.

WHERE DOES VOC ORIGINATE?

Many VOC's in the atmosphere are naturally occurring – they evaporate from vegetation^{iv}, such as monoterpenes from pine trees and isoprene from deciduous trees. Mowing grass and harvesting hay also release VOC into the air. The blue haze over the Blue Mountains is eucalyptus oil. Ethanol, present in the wine we drink is the fermentation product of fruit sugars, and citrus oil is a natural, and very effective cleaning agent.

A rising proportion of VOC's in the atmosphere are man-made, however. These VOC's are synthesized from fossil fuels (ie petroleum based), and certainly not limited to paint and coatings; they exist in a very broad range of products including but not limited to food, household cleaning agents, glues, fabric linings, joint sealants, carpet backing, adhesives for carpet and tiles and plastics.



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VOC IN PAINT AND COATINGS

Most **conventional protective coatings** contain **VOC's**, which evaporate and are released into the air during application and as the paint dries. In **coatings**, **VOC** is also known as **solvent** or **thinner**.

WHAT EFFECT DOES VOC HAVE?

The release of VOC's may affect the paint applicator, the occupant of the space in which the product was used, and the environment.

EFFECT ON THE APPLICATOR (OH&S)

The VOC's released during application (and as the paint dries) may trigger respiratory reactions including asthma, and breathing discomfort, when inhaled and other symptoms such as dizziness and nausea.^v They can also cause skin irritation on contact. Wearing appropriate personal protection and engineering controls during application can prevent such adverse reactions.^{vi}

EFFECT ON THE OCCUPANT (INDOOR AIR QUALITY)

Generally, improvements in building insulation and draft minimisation in building design have also created ventilation challenges. VOC's and other chemicals that "off-gas" may take some time to dissipate, and flinging open windows to allow cross ventilation is not possible in building with fixed windows and controlled climates. According to the ABS, "Newer buildings are particularly at risk of hazardous air pollution due to low ventilation rates and 'off-gassing' of new building materials. 'Off gassing' refers to the releases of toxic fumes from **furniture, carpets, paints*, glues** and **sealants** used in building products. These fumes are greatest in new buildings and may remain high for several months (EA 2001a)."^{vii} (*Water borne paint does not contain any of the chemicals listed as air pollutants therein.)

EFFECT OF VOC ON THE ENVIRONMENT

Industries that had traditionally used large quantities of low-solids, high solvent paint, such as the automotive and furniture industries, had accounted for a significant proportion of total VOC emission. In the US, VOC emission from coating industries almost rivalled vehicle emission only 20 years ago. The US and particularly California lead the way on VOC limits, however the driver was based on low-level atmospheric pollution rather than the associated contribution to the green-house gas issue. Much of what has been used as a framework for ESD issues has been drawn from legislation in place to control low-level atmospheric pollution – a related issue, but not the same issue. Hence there are flaws in the translation.

For example, consider the general purpose organic solvent, acetone, used in many products such as nail varnish thinner and remover until it was replaced with the more benign thinner, ethyl acetate. Acetone is somewhat hazardous to inhale or absorb through skin contact. Yet the APAS no longer lists acetone as a VOC as there is no evidence at present that it has a photochemical effect in the atmosphere^{viii}.

Nevertheless, on the whole, reducing VOC emissions where we can reduces photochemical smog and reduces contribution to the Greenhouse Effect.



Wearing the correct personal protection equipment according to State laws will prevent inhalation of atomised paint particles and solvent



Indoor air quality is of paramount importance for future building occupants



Acetone was the main component of nail varnishes and varnish removers, however most manufacturers now use ethyl acetate

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THEN WHY ADD VOC? THE TRADITIONAL ROLE OF SOLVENTS IN PAINT

Solvents are normally included in conventional oil based coatings for a number of reasons, such as:

- Solution medium – the resin is dissolved or dispersed in the solvent.
- Paint carrier - pigment powders and other additives are dispersed in the solvent and hence “carried” by the solvent. The solvent also carries the paint from the can to the substrate via brush, roller or spray. Once the paint is applied, the solvent no longer has any use. It evaporates, leaving a thin, smooth film on the substrate.
- Paint thinner and/or flow modifier - if the paint is too thick to apply easily (temperature can cause paint to thicken), solvent can be added to adjust the flow-out

Reformulation of protective coatings to reduce VOC levels must take these points into account to ensure that the reformulated product is not more difficult to apply.

A small amount of VOC is normally included in water-borne paints to:

- improve “wet edge” by prolonging evaporation long enough to allow the paint to flow out,
- improve coalescence of the latex particles as the water dries.

Water-borne paints have a solvent level of around 8%, so using a water-borne paint seems to be a more environmentally responsible option, assuming performance properties are equal to those of the solvent-borne equivalent. Low VOC coatings, either water-borne, or solvent-free, are readily available on the market.

ARE ALL VOC'S BAD?

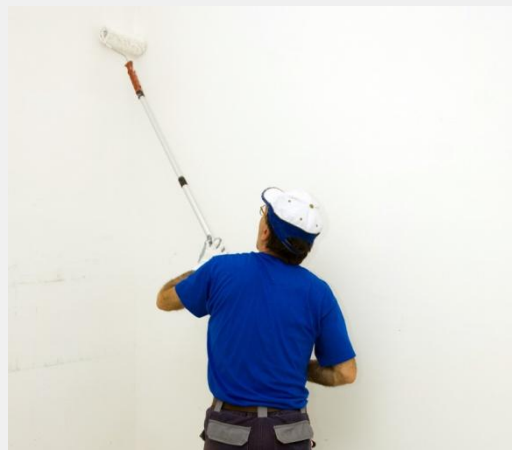
All organic additives that evaporate from paint as it dries are classified as VOC's, regardless of relative potential for harm. In other words, a particular organic chemical may be found in a range of food and beverages, face creams or household items, but as part of a paint formula, if it evaporates, it is considered a VOC.

VOC's differ widely with regard to their effect on the environment; whilst some do contribute to the greenhouse gas effect (or when not used in accordance with safety advice, pose occupational health and safety risks for the user), others are chemically identical to naturally occurring VOC's.

Then there is the issue of acetone not being classified as a VOC, despite fitting the chemical definition (volatile and organic) and being harmful to humans.

IS LOW VOC THE SAME AS LOW ODOUR?

LOW VOC must not be confused with **LOW ODOUR**. Some low VOC paints have a strong, distinct odour, whilst some higher VOC paints have a low or pleasant odour. Certain solvent-free products (i.e. zero VOC) have an odour during application and drying but the odour dissipates fairly quickly as the product cures. Check data sheets and ask reliable technical consultants for VOC values.



Solvents improve “wet edge” and help prevent the paint from drying out too quickly during application



If the paint dries out too quickly during application, it becomes too thick and stringy to allow a good finish



Spray painting results in a superior finish, but such coatings are generally high in VOCs and the method produces loss due to “overspray”



Wine is around 12-14% VOC (ethanol)

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VOC EMISSIONS - SHORT TERM VS LONG TERM

Some types of low VOC coating technologies, such as waterborne acrylic paints, have enormous and obvious advantages over traditional coating systems in certain applications where the protection is adequate in that situation.

In the case of structural steel in a coastal environment, however, a water borne acrylic paint would probably last months, not years, and attempting to control corrosion by frequent repainting is clearly not sustainable.

A balance must be reached between initial VOC emissions (short-term ecological cost) and substrate protection and durability (long-term ecological benefits).^{ix}

A rough balance between VOC emissions and long term durability can be calculated on a life cycle basis. Please see below for a working example.

A SIMPLE LIFE CYCLE ASSESSMENT EXAMPLE

OPTION 1 – ENAMEL PAINT VS SILICONE ENAMEL

Using the example of a quick dry alkyd enamel such as Metalshield, with a VOC level of 510 grams per litre, for every four litre can used, approximately 2 kilograms of VOC are emitted into the atmosphere, compounding the “Greenhouse Effect”. Given that alkyd enamels readily chalk and deteriorate when exposed to UV and exterior exposure generally, maintenance repainting is generally necessary on commercial projects every 3-5 years. For a life cycle of, say, 60 years, this equates to 12 repaints.

For an area that requires four litres of coating, the solvent released over 60 years would be

$$= 12 \times 2.04 \text{ kilograms} = \underline{24.5 \text{ kilograms}}$$

Substituting the quick-dry enamel with a **silicone enamel** paint, such as **Metalshield Premium UV Resistant Enamel**, (VOC level is 450 grams per litre) increases the maintenance period to about **7.5 years**, which over 60 years, means about 8 repaints

$$= 8 \times 1.8 \text{ kilograms} = \underline{14.4 \text{ kilograms}}$$

OPTION 2 – STANDARD TWO-PACK POLYURETHANE

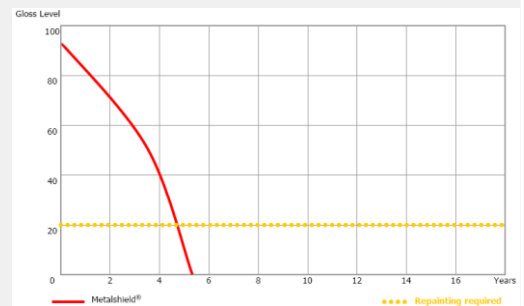
Replacing the single pack enamel with a **high performance polyurethane** topcoat such as Dulux **Luxathane[®] R** with a **VOC level of 500 grams per litre** (mixed), then for every four-litre kit used, **2 kilograms** of VOC are emitted into the atmosphere. Repainting a substrate topcoated with **Luxathane[®] R** may be necessary only every 12 years. For a life cycle of, say, 60 years, this equates to **5 repaints**.

For an area that requires four litres of coating, the solvent released over **60 years** would be

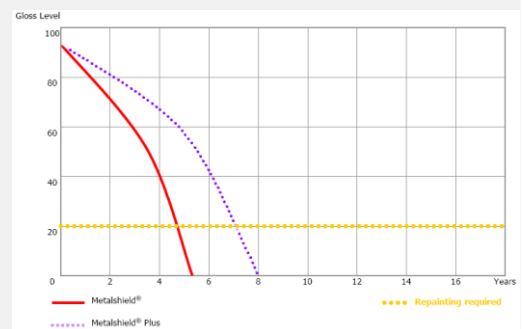
$$= 5 \times 2 \text{ kilograms} = \underline{10 \text{ kilograms}}$$



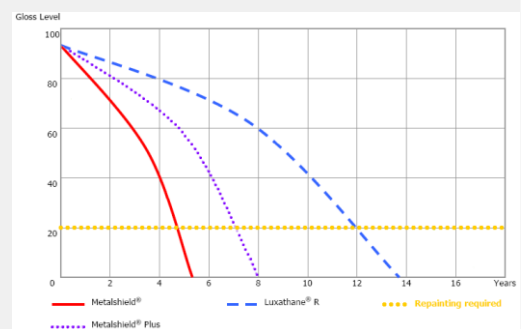
All environmental impacts such as frequency of maintenance, thermal energy inputs and HAPS should be considered



A quick dry enamel paint may be quick and easy but inadequate UV protection means greater maintenance costs and more demands on resources



A silicone enamel offers greater UV protection and longer maintenance times.



A two pack polyurethane may contain a higher level of VOC, but offers far greater UV protection and barrier protection, and hence lower maintenance and lower VOC emissions in the long run.

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OPTION 3 – HIGH SOLIDS TWO-PACK POLYURETHANE

If, however, **Luxathane® R** is replaced with Dulux **Weathermax® HBR**, with a **VOC level of 330 grams per litre** (mixed), a four-litre kit releases only **1.32 kilograms** of VOC, and offers further increased protection to the substrate, and may require repainting every 15 years. For a life cycle of, say, 60 years, this equates to **4 repaints**.

For an area that requires four litres of coating, the solvent released over **60 years** would be

$$= 4 \times 1.32 \text{ kilograms} = \underline{\underline{5.3 \text{ kilograms}}}$$

So there you go – by choosing the right coating system you are reducing VOC emissions into the atmosphere by a whopping 19.2 kilograms per each 20 litre pack used over a 60 year period.

Therefore, using a high performance **protective coating** is economically, as well as ecologically, sound **in the long term**, as repaints are less frequent.

But the benefit is not limited to using less paint over a given life cycle there are also the enormous savings in raw material mining and processing, packaging and transport to the paint manufacturer, then the manufacturing processes, packaging and transport to various paint outlets.

A **balance** must also be reached between **VOC emissions** of applying a coating and its corresponding effect on the environment compared with **alternative methods of substrate protection**.^x For more information on other environmental considerations when choosing a protective coating, please refer to Dulux Protective Coatings Tech Note 2.3.1 ESD – Definitions and Measurement and Tech Note 2.3.3 ESD and Galvanic Corrosion Protection.

WHAT HAS DULUX PROTECTIVE COATINGS ACHIEVED?

Some years ago, **Dulux Protective Coatings** made a commitment to developing **high performance, low VOC** technology products to replace conventional solvent-borne products in a range of **heavy-duty applications** such as industrial flooring and steelwork.

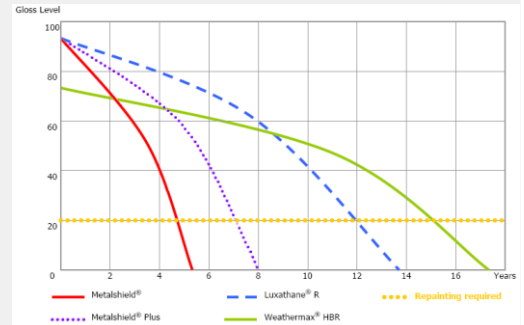
Our world-class research and development laboratories at Clayton are fulfilling this commitment. To date, our efforts have resulted in the products below.

WATER BORNE PROTECTIVE COATINGS^{xi}

Aquagalv [®]	inorganic zinc silicate anti corrosive primer
Enviro epoxy [®] WBE	Waterborne two-pack epoxy acrylic coating
Ferreko [®] No. 5	Waterborne single pack acrylic MIO coating
Luxafloor [®] ECO ₂	Low VOC two-pack epoxy floor coating

HIGH SOLIDS PROTECTIVE COATINGS

Luxafloor [®] RollCoat	High solids, low VOC two-pack epoxy floor coating
Weathermax [®] HBR	High solids, high performance two-pack polyurethane coating
Durebild [®] STE	High solids, surface-tolerant two-pack epoxy coating
Duremax [®] GPE	High solids, high build two-pack epoxy intermediate coating



A high solids polyurethane offers even greater protection, significantly lower maintenance and significantly lower VOC emissions in the long run



The eco designed Tallawarra Power Station's steelwork – Aquagalv.



The Green Bridge's steelwork – Ferreko No 3



Silt Cafe's diamond ground concrete floor – Luxafloor ECO₂ Clear

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GREEN SPECIFICATIONS

When it comes to specifying coating systems for projects being designed within Green Star guidelines or you simply wish to minimise impact on the environment, call your Dulux Consultant. Many of our Consultants actively and regularly attend environmental conferences, seminars and training sessions, and can help you to specify the most **environmentally responsible** coating systems for your project.

For more information, please contact the Dulux Protective Coatings Technical Consultant in your state.

 **VALUE PEOPLE, WORK SAFELY & RESPECT THE ENVIRONMENT**

Dulux is a member of the Green Building Council of Australia.



green building council australia
MEMBER

ⁱ Green Building Council Australia www.gbcaus.org

ⁱⁱ APAS Document D181, Volatile Organic Compounds (VOC) Limits
www.apas.gov.au/PDFs/D181.pdf

ⁱⁱⁱ USA EPA www.epa.gov/air/caa/peg/cleanup.html

^{iv} More than a change of color: Autumn foliage may affect air quality, climate.
www.ucar.edu/communications/staffnotes/0110/foilage.html

^v Dulux Protective coatings Tech Note 2.2, Correct and safe Use of Solvents
www.duluxprotectivecoatings.com.au/technotespdf/2.2%20Solvents.pdf

^{vi} Dulux Protective Coatings Tech Note 2.3 Solvents,
www.duluxprotectivecoatings.com.au/tech_notes.html

^{vii} Indoor Air Pollution, EA 2001a, www.abs.gov.au

^{viii} APAS Document D181, Volatile Organic Compounds (VOC) Limits
www.apas.gov.au/PDFs/D181.pdf

^{ix} Dulux Protective Coatings Tech Note 2.3.3 ESD and Coating Specifications

^x Dulux Protective Coatings Tech Note 2.3.4 ESD and Corrosion Protection

^{xi} Dulux Protective Coatings Data Sheets: www.duluxprotectivecoatings.com.au/data-sheets.shtml