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Development of the EU Green Public Procurement (GPP) Criteria for Paints, Varnishes and Road Markings

Technical Report with final criteria

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Abstract
The Development of the Green Public Procurement (GPP) criteria for Paints, Varnishes and Road Markings is aimed at helping public authorities to ensure that paints, varnishes and road markings are procured in such a way that it delivers environmental improvements that contribute to European policy objectives for energy, chemical management and resource efficiency, as well as reducing life cycle costs. In order to identify the most significant improvement areas for criteria development an analysis has been carried out of the environmental and health impacts of manufacturing and using paints, varnishes and road markings. The most commonly used procurement processes have been also identified and are further addressed in the separate criteria document (published as a Staff Working Document of the Commission). Together these two documents aim to provide public authorities with orientation on how to effectively integrate these GPP criteria into their procurement processes.

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1 INTRODUCTION AND PROJECT BACKGROUND

Green Public Procurement (GPP) is defined in the Commission Communication "Public procurement for a better environment"[1] as "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured". This is a voluntary instrument, which public authorities can use to provide industry with incentives for developing and marketing more environmentally sound products.[2]

The development of EU GPP criteria aims to help public authorities ensure that the goods, services and works they require are procured and executed in a way that reduces their associated environmental impacts. The criteria are thus formulated in such a way that they can be, if deemed appropriate by the individual authority, integrated into its tender documents with minimal editing.

GPP criteria are to be understood as being part of the procurement process and must conform to its standard format and rules as laid out by Public Procurement Directive 2014/24/EU (public works, supply and service contracts). Hence, EU GPP criteria must comply with the guiding principles of: Free movement of goods and services and freedom of establishment; Non-discrimination and equal treatment; Transparency; Proportionality and Mutual recognition. GPP criteria must be verifiable and it should be formulated either as Selection criteria, Technical specifications, Award criteria or Contract performance clauses, which can be understood as follows:

Selection Criteria (SC): Selection criteria refer to the tenderer, *i.e.*, the company tendering for the contract, and not to the product being procured. It may relate to suitability to pursue the professional activity, economic and financial standing and technical and professional ability and may- for services and works contracts - ask specifically about their ability to apply environmental management measures when carrying out the contract.

Technical Specifications (TS): Technical specifications constitute minimum compliance requirements that must be met by all tenders. It must be linked to the contract's subject matter (the 'subject matter' of a contract is about what good, service or work is intended to be procured. It can consist in a description of the product, but can also take the form of a functional or performance based definition.) and must not concern general corporate practices but only characteristics specific to the product being procured. Link to the subject matter can concern any stage of the product's life-cycle, including its supply-chain, even if not obvious in the final product, *i.e.*, not part of the material substance of the product. Offers not complying with the technical specifications must be rejected. Technical specifications are not scored for award purposes; they are strictly pass/fail requirements.

Award Criteria (AC): At the award stage, the contracting authority evaluates the quality of the tenders and compares costs. Contracts are awarded on the basis of most economically advantageous tender (MEAT). MEAT includes a cost element and a wide range of other factors that may influence the value of a tender from the point of view of the contracting authority including environmental aspects (refer to the Buying Green guide for further details). Everything that is evaluated and scored for award purposes is an award criterion. These may refer to characteristics of goods or to the way in which services or works will be performed (in this case they cannot be verified at the award stage since they refer to future events. Therefore, in this case, the criteria are to be understood as commitments to carry out services or works in a specific way and should be monitored/verified during the execution of the contract via a contract performance clause). As technical specifications, also award criteria must be linked to the contract's subject matter and must not concern general corporate practices but only characteristics specific to the product being procured. Link to the subject matter can concern any stage of the product's life-cycle, including its supply-chain, even if not obvious in the final product, *i.e.*, not part of the material substance of the product. Award criteria can be used to stimulate additional environmental performance without being mandatory and, therefore, without foreclosing the market for products not reaching the proposed level of performance.

1 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Public procurement for a better environment, COM (2008) 400, available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0400:FIN:EN:PDF.

2 GPP website http://ec.europa.eu/environment/gpp/what_en.htm.

Contract Performance Clauses (CPC): Contract performance clauses are used to specify how a contract must be carried out. As technical specifications and award criteria, also contract performance clauses must be linked to the contract's subject matter and must not concern general corporate practices but only those specific to the product being procured. Link to the subject matter can concern any stage of the product's life-cycle, including its supply-chain, even if not obvious in the final product, *i.e.*, not part of the material substance of the product. The economic operator may not be requested to prove compliance with the contract performance clauses during the procurement procedure. Contract performance clauses are not scored for award purposes. Compliance with contract performance clauses should be monitored during the execution of the contract, therefore after it has been awarded. It may be linked to penalties or bonuses under the contract in order to ensure compliance.

For each criterion there is a choice between two levels of environmental ambition, which the contracting authority can choose from according to its particular goals and/or constraints:

The **Core criteria** are designed to allow easy application of GPP, focussing on the key areas of environmental performance of a product and aimed at keeping administrative costs for companies to a minimum.

The **Comprehensive criteria** take into account more aspects or higher levels of environmental performance, for use by authorities that want to go further in supporting environmental and innovation goals.

As said before, the development of EU GPP criteria aims to help public authorities ensure that the goods, services and works they require are procured and executed in a way that reduces their associated environmental impacts and is focused on the products' most significant improvement areas, resulting from the cross-check between the key environmental hot-spots and market analysis. This development also requires an understanding of commonly used procurement practices and processes and the taking on board of learnings from the actors involved in successfully fulfilling contracts.

Therefore, the European Commission's Directorate General for the Environment has initiated a project directed towards developing a joint evidence base for the EU policy making in the area of paints, varnishes and road markings. This study has been being carried out by the Joint Research Centre Institute for Prospective Technological Studies (JRC-IPTS) supported by Oakdene Hollins consultancy, in cooperation with all the interested parties.

The purpose of this project was to develop Green Public Procurement criteria for paints, including road markings in parallel to the revision of the EU Ecolabel criteria for indoor and outdoor paints and varnishes.

The results of the study and the milestones are available at the project's website (http://susproc.jrc.ec.europa.eu/paints/). The current working document summarises background information on paints, varnishes and road markings environmental performance, proposes EU GPP criteria for this product group and explains the rationale behind the said proposals.

The primary goals of establishing these criteria for paints are to promote in the public sphere purchasing products that have a lower environmental impact along their life cycle, are of high quality (have good performance and long durability), contain a limited amount of hazardous substances and volatile organic compounds. High quality and performance standards of the paint are required to ensure the longevity of the product and contribute that way to the significant reduction of the paints' overall life cycle impacts. The proposed EU GPP criteria should not entail significant cost increases to the public contracting authority when evaluated using a life-cycle cost perspective (e.g., lower overall costs due to better durability and less frequent need of repainting).

The document consists of the following chapters: Chapter 1 introduces the project background; Chapter 2 presents briefly the product definition and scope; Chapter 3 shows market and cost considerations, including life cycle costing. It is followed by Chapter 4, which summarises the results of the technical analysis in support of the proposed GPP criteria, which are then presented in Chapter 5.

2 PRODUCT DEFINITION AND SCOPE

2.1 Paints, varnishes and road markings

Within the context of this study, the definition of a paint used is the same with the one used in the EU Ecolabel criteria revision process and based on the definition of a coating given in the Directive 2004/42/CE[3].

The product group **'Paints and Varnishes** shall comprise indoor and outdoor paints and varnishes, woodstains and related products, as defined below, intended for use by professional users (please note that these are not industrial users).

'Road markings' are addressed separately as a specific product with distinct characteristics and performance requirements. The definition used for road markings is the outcome of the undertaken consultation based on the definitions from existing standards.

Paint and varnish products include, inter alia:

- Floor paints,
- Products which are tinted by distributors at the request of professional decorators,
- Tinting systems,
- Decorative paints in liquid or paste formulas which may have been pre-conditioned, tinted or prepared by the manufacturer to meet consumer's needs, including wood paints, wood and decking stains, masonry coatings and metal finishes primers and undercoats of such product systems as defined within Directive 2004/42/CE Annex I 1.1.d and 1.1.g.

'Paint' means a pigmented coating material, in liquid or in paste form, which, when applied to a substrate, forms an opaque film having protective, decorative or specific technical properties.

'Decorative paints and varnishes' means paints and varnishes that are applied to buildings, their trim and fittings, for decorative and protective purposes. While their main function is decorative in nature, they also have a protective role.

'Masonry coatings' are coatings that produce a decorative and protective film for use on concrete, (paintable) brickwork, blockwork, rendering, calcium silicate or fibre-reinforced cement. They are mainly intended for exterior use, but may also be used internally, or on soffits and balcony ceilings.

'Varnish' means a clear coating material which, when applied to a substrate, forms a solid transparent film having protective, decorative or specific technical properties.

'Woodstains' (lasures) means coatings producing a transparent or semi-transparent (using substantially non-white pigment) film for decoration and protection of wood against weathering, enabling maintenance to be carried out easily.

'Tinting system' means a method of preparing coloured paints by mixing a 'base' with coloured tints.

'Road marking' means products such as paint or structural plastic systems which are applied to road surfaces in order to delineate traffic lanes, bays and signals, as well as to provide frictional properties and night time retro-reflection in dry, wet and rain conditions. They are generally composed of a pigmented road marking material and glass beads which, together, may or may not form a film over the substrate. Preformed road marking products defined as tape, preformed cold plastic road marking or preformed thermoplastic road marking with or without drop-on materials are also included in the scope. Mechanical markings such as cat's

3 Directive 2004/42/CE of the European Parliament and of the Council of 21 April 2004 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, OJ 143, 30.4.2004, p. 87.

eyes are not included. Primers and adhesives needed for application of the road marking material are also included.

The product group shall not comprise:

- anti-fouling coatings;
- wood preservation products;
- coatings for particular industrial and professional uses, including heavy-duty coatings;
- powder coatings;
- UV curable paint systems;
- paints primarily intended for vehicles;
- product which primary function is not to form a film over the substrate, e.g. oils and waxes (with the exception of certain road marking systems);
- products that do not form film over the substrate, with the exemption of road markings;
- transparent chemical floor coatings using reactive resins as binders for thick layer coverings for industrial floors.

Supporting technical definitions relating to paint specifications are given below:

'White and light coloured' paints are those with a tri-stimulus (Y-value) > 70%;

'Gloss paints' are those which at an angle of incidence of 60o show a reflectance of ≥ 60;

'Mid sheen paints' (also referred to as semi-gloss, satin, semi-matt) are those which at an angle of incidence of 60o or at 85o show a reflectance of < 60 and ≥ 10;

'Matt paints' are those which at an angle of incidence of 85o show a reflectance of <10;

'Dead matt paints' are those which at an angle of incidence of 85o show a reflectance of <5;

'Transparent' and 'semi-transparent' means a film with a contrast ratio of < 98% at 120µ wet film thickness;

'Opaque' means a film with a contrast ratio of > 98% at 120µ wet film thickness;

'Volatile organic compounds' (VOC) means any organic compounds having an initial boiling point less than or equal to 250 °C measured at a standard pressure of 101,3 kPa as defined in Directive 2004/42/EC and which, in a capillary column, are eluting up to and including n-Tetradecane (C14H30);

'Semi volatile organic compounds' (SVOCs) means any organic compound having a boiling point greater than 250 °C and less than 370 °C measured at a standard pressure of 101,3 kPa and which, in a capillary column are eluting with a retention range after n-Tetradecane (C14H30) and up to and including n-Docosane (C22H46).

Follow-up from the stakeholders' consultation

➢ Definition of road markings

One of the issues mentioned was related to the fact that the previous definition of road markings did not specify clearly whether preformed products were included in the scope or not. Their inclusion was supported by the stakeholders.

The EN 1790[4] refers to preformed road markings as follows:

"A particular category of road marking materials, used for horizontal signalisation, are preformed, i.e. manufactured products in sheet form, ready for use on the road. They can be applied by means of adhesives, pressure or heat, with or without the use of a primer. Preformed road marking

[4] EN 1790 Road marking materials. Preformed road markings.

materials can be linear, in pieces of a certain length or in rolls. They can also be cut out in the form of symbols or signs or parts of them, making it possible to assemble them on the road to achieve the desired shape.

Preformed road marking materials can be designed for use as permanent or temporary road markings. In both cases they can be applied with a view to later removal and therefore the specific property of "removability" can be required.

Preformed road marking products are defined as Tape, preformed Cold Plastic road marking or preformed Thermoplastic road marking with or without drop-on materials.

Except for Thermoplastic road markings with drop-on materials, all the other type of products are fully finished during manufacturing and do not change significantly their properties during application.

Thermoplastic road markings with drop-on materials need the addition of drop-on materials during application on the road and therefore they are in some way similar to thermoplastic products covered by EN 1871[5]".

It is proposed to add in the definition specific reference based on the above standard, which clearly indicates that preformed markings are included in the scope. In addition, it was requested in the last round of consultation that it is explicitly mentioned that primers and adhesives which are used for instance to apply type, shall be mentioned in the definition. Respective amendments were made and the new definition is as follows:

> '**Road marking**' means products such as paint or structural plastic systems which are applied to road surfaces in order to delineate traffic lanes, bays and signals, as well as to provide frictional properties and night time retroreflection in dry, wet and rain conditions. They are generally composed of a pigmented road marking material and glass beads which, together, may or may not form a film over the substrate. Preformed road marking products defined as tape, preformed cold plastic road marking or preformed thermoplastic road marking with or without drop-on materials are also included in the scope. Mechanical markings such as cat's eyes are not included. Primers and adhesives needed for application of the road marking material are also included.

2.2 Works contracts

The criteria are set not only on final products but covers in addition related painting and road marking works contracts. These can include one-off works contracts; call down contracts from a framework as well as cyclical, long-term painting services. All contracts shall be based on the use of paint products defined within the scope of this product group. The following contract definitions are used in these criteria set:

'Painting works' means when contractors, usually termed 'painters and decorators', are directly engaged to paint indoor or external surfaces on a one-off, call down or cyclical basis, including ongoing maintenance and remedial works.

'Road marking works' means when contractors, usually termed 'road marking operatives', are directly engaged to apply road markings on a one-off or cyclical basis, including maintenance and remedial works.

[5] EN 1871:2000 Road marking materials. Physical properties.

3 MARKET AND COST CONSIDERATIONS

3.1 Market considerations

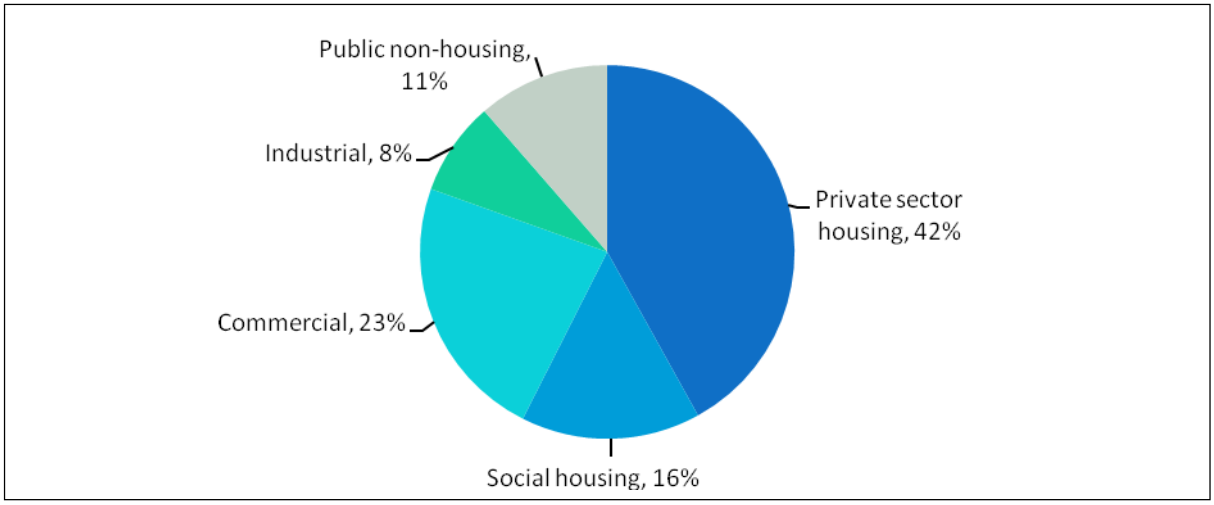
Public authorities are major consumers in Europe, spending "2 trillion euros annually, equivalent to some 19% of the EU's gross domestic product".[6] Therefore, any shift of public spending towards products with lower environmental impacts has the potential to make an important contribution to more sustainable production and consumption. Green public procurement also has the potential to influence the market by providing industry with incentives for developing more environmentally-friendly technologies and products.

In the published technical report associated with the EU Ecolabel and development of the GPP criteria for paints (available at the project website[7]) is provided a detailed market analysis for paints. The report also includes estimates of future trends for these products. The below sections summarise the main information available for the public sphere and presents life cycle cost analysis.

Public procurement

In accordance with the findings of the Palmer market research report on paints, in terms of public procurement, 16% of the total market of paints is used for social housing and 11% for public non-housing. The shares of various sub-sectors in this market for the year 2006 are presented in Figure 1.

Figure 1: Trade paints market by sector 2006 (% share in sector)



Source: Trade paints market report, Great Britain, Palmer market research, 2007.

Within the trade paints market, 86% of the volume of paint is for existing buildings (mainly redecoration) rather than on new buildings. This high figure is true across all sectors: for example, for social housing, 92% of paint used is for redecoration rather than on new buildings.

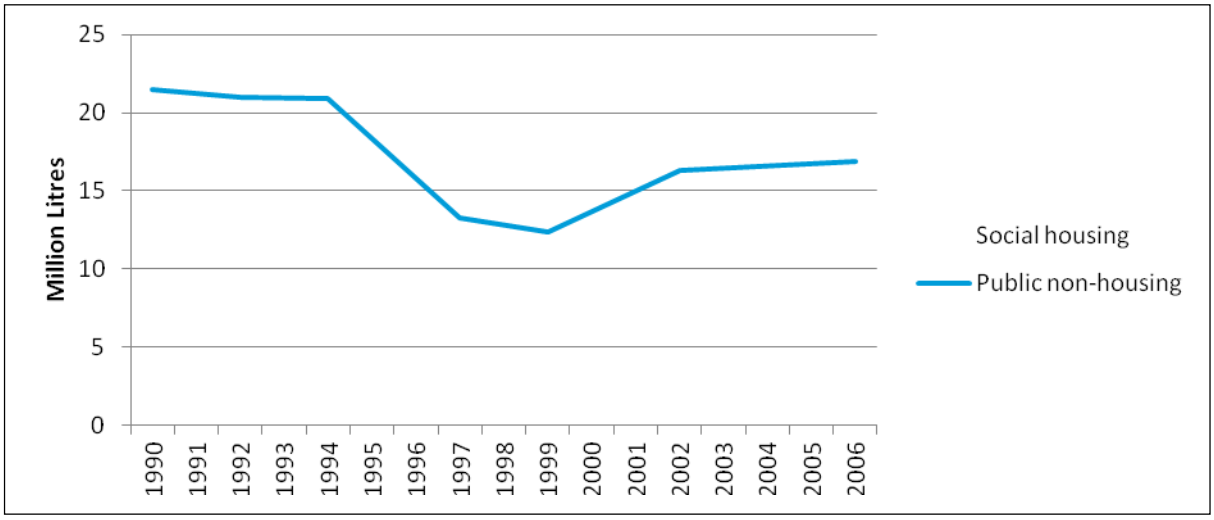
6 According to information available at the DG Environment website: http://ec.europa.eu/environment/gpp/what_en.htm, accessed April 2014.

7 "Revision of EU European Ecolabel and Development of EU Green Public Procurement Criteria for Indoor and Outdoor Paints and Varnishes" (June 2012), http://susproc.jrc.ec.europa.eu/paints/stakeholders.html.

The public sector across Europe does not usually procure paints and coatings directly from the manufacturer, but uses professional contractors, painters and construction companies. In turn, these contractors purchase their paint from manufacturers or through wholesale or distributor channels.

In 2006, only 14% of trade paint used in the social housing sector was applied by local authorities and public sector bodies, the remainder being applied by decorating firms and builders. Similarly, in the public non-housing sector most of the paint was applied by decorating firms, with local authorities and public sector bodies only accounting for 5%. This makes it difficult to trace the volume of that is used in the public sector. Figure 2 displays the trends in the paint trade market sector for social housing and public non-housing in Great Britain (Data for 2007-11 are forecasts only).

Figure 2: Trends in the trade paints market sector, public sector use in GB (2007-11)*



* Data is available for 1990, 1992, 1994, 1997, 1999, 2002 and 2006. All other figures have been extrapolated from these data points.
Source: Trade paints market report, Great Britain, Palmer market research, 2007.

The paints market is relatively steady and although Figure 2 shows volume changes, these are within a relatively small range. Between 1990 and 2006, public sector trade paint (in social housing and public non-housing) moved from a 26% share in the total trade paints market to a 27% share.

It is also not clear what is driving changes to paint use. A number of aspects could be having an impact on the amounts of trade paint used in the public sector, including economic, social and regulatory factors. For example, the UK Decent Homes Programme which set targets to improve all social sector homes by 2010, would have acted as a likely significant driver for increased paint use.

Currently, EU legislation (i.e. the Paints Directive 2004/42/EC) broadly specifies the types of paint that can be used within Europe, ensuring paints containing heavy metals or high VOC contents are not used. Some Member States have themselves set more stringent measures, again relating to these factors.

Europe's GPP strategy may have an impact on the types of paints that are used. As demand for eco-friendly paints in the domestic paints market grows, it may be that more contractors offer customers the opportunity to choose from ranges of environmentally-friendly products. According to Greenbuild News portal, an example of this can be found in the UK, where Low Carbon Products Ltd. has developed a range of paints using between 90-95% recycled paint in each pot. Recycled paint is collected from commercial users and would otherwise have gone to landfill. The company supply the paint to public sector organisations as well as trade customers. Additions to the paint, including

anti-bacterial, anti-graffiti and anti-chewing gum properties, make the product suitable for health and public buildings.[8]

Within the UK, public sector is estimated to account for 23% of total sales of decorative paints in 2008. Across the EU there is, however, a lack of available data with regards to public procurement of paints and varnishes.

3.2 Cost considerations

In the development of Green Public Procurement criteria, one of the most important aspects to take into account is a life-cycle cost analysis of the best environmentally-performing products with respect to average products in the market. Cost considerations (using a life-cycle perspective) are very important in the public sphere as this contributes in the justification of public spending. Member states should be encouraged to make choices that are a good value in the long-term.

3.2.1 Introduction to life cycle costing

In order to allow public procurers to select the products that will be most cost-effective it is recommended to use a product life cycle perspective and apply a life cycle cost (LCC) approach. LCC considers the entire (physical) life cycle of a product, from production to disposal. Depending on the perspective taken in the LCC assessment, costs of different stages can be calculated with more or less detail. The use phase of the life cycle is relevant for the public procurers since this cost will be incurred. The production cost of the product to be purchased does not need to be calculated in detail, since the relevant cost element for the purchasing authority would be integrated in the final product price.

Many procured items, such as computers or printers, require electricity and consumables to function and the costs of these can often exceed the initial purchase cost of the item. For paints and varnishes the life time costs are generally only incurred at the point of painting. The main considerations for calculating the life cycle costs are the:

- cost of purchasing and delivery (e.g. cost per litre of paint or varnish as delivered);
- application performance (e.g. amount of paint required to cover a given surface area);
- lifetime performance (number of repaints required to maintain coverage over time);
- disposals costs (disposal of unused paints).

Costs that may theoretically be incurred but were not considered were:

- For outdoor paints, the change in thermal performance for the building:
    - The choice of colour is the dominant factor affecting thermal performance.
- Labour time and equipment cost for application of the paint:
    - It would be impossible to meaningfully establish costs and differentiate products based on this variable.
- Additional disposal costs at the end of life for the painted surface:

[8] For more information see http://www.greenbuildnews.co.uk/article-details/Recycled-paint-range/209.

- Disposal cost of the painted surfaces are unlikely to be affected by the paint that was applied
- Indoor paints: any energy saving from having a lighter painted room and therefore less use of artificial light.

The aforementioned costs have also environmental costs which are commonly studied under the frame of "environmental externalities" but these were not considered relevant for a report supporting the development of GPP criteria and were not included in the analysis.

It is important to highlight that in this context it is evident that when assessing the overall costs it is not sufficient to consider solely the advertised cost per litre of paint.

3.2.2 Functional unit and reference flow

Functional Unit

To calculate the life cycle cost of each paint it is necessary to define a functional unit of interest. The functional unit for this life cycle costing was chosen to be the cost of paint required to cover a 20 m^2 surface for a period of 21 years, given a baseline assumption that a repaint is required every 7 years to maintain sufficient coverage. This is the same functional unit that is applied to the life cycle assessment of the paints.

The variables that are required to calculate the functional unit are:

- cost per litre of paint;
- spreading rate to meet performance criteria;
- time between repaints to maintain performance criteria;
- expected losses due to wastage;
- disposal costs of waste paint.

Two types of paint are considered: a water-based vinyl emulsion and a water-based alkyd varnish; these are the paints investigated in the life cycle assessment portion of the work. Vinyl emulsion is used for both indoor and outdoor paints and will be analysed separately. With regard to road markings, the overall LCC is likely to be different due to length of time between repaints.

Reference flow of a baseline scenario

The reference flow is the amount of paint required to fulfil the functional unit being investigated. By calculating the reference flow and multiplying it by the cost per litre of paint, the full life cycle cost can be established.

The following sections discuss the factors affecting the reference flow of paint required to fulfil the functional unit.

Spreading rate

The current EU Ecolabel criteria state that white paints and light-coloured paints (including finishes, primers, undercoats and/or intermediates) shall have a spreading rate of at least 8 m^2 per litre of product for indoor paints and 6 m^2 per litre for outdoor paints. This is taken as the spreading value for the baseline costing. Therefore the reference flow to paint a single 20 m^2 surface using vinyl emulsion paint is 2.5 litres of paint indoors or 3.3 litres of paint outdoors.

Alkyd water-based varnishes typically apply a clear coating onto wooden surfaces. It is therefore not possible to define a spreading rate criterion that is based on opacity. Technical data sheets for a number of alkyd varnishes were used to calculate an estimated spreading ratio of 5.5 m^2 per litre[9,10]. Therefore the baseline reference flow to paint a single 20 m^2 surface is 3.6 litres of paint.

Time between repaints

The amount of time between repaints of a surface to maintain the required performance standard is a significant variable in calculating the reference flow of paint over the functional unit. The baseline assumption is that a repaint would be needed every 7 years, requiring three separate paint applications in order to satisfy the performance criteria over the 21 years stipulated in the functional unit. The baseline reference flow must therefore be multiplied by a factor of three to achieve this.

Expected losses due to wastage

A recent study of WRAP[11] highlights the problem of unused paint in the UK. In the Do-It-Yourself (DIY) market, an estimated 25% of all paint goes unused, whereas with trade this figure is 1.5%. Stakeholders involved in the consultation process believe that 25% is too high and a figure closer to 10% is more accurate.

For the GPP criteria it is most applicable to consider the trade waste percentage, which is relatively low at 1.5%.

The baseline reference flow for the amount of paint required must therefore be multiplied by a factor of 1.015 to take into account paint wastage. The reference flow for calculating the disposal costs of the paint are calculated by multiplying the reference flow before wastage by 0.015. This calculation assumes that the wastage rate is defined as the additional paint that is procured and then disposed of beyond the requirements to fulfil the tasks.

Reference flow for the functional unit

Table 1 shows the baseline total reference flows for the three scenarios that were discussed. The three scenarios, differentiated only by spreading rates, have very different reference flows. The alkyd scenario requires 45% more paint than the indoor vinyl emulsion scenario.

Table 1: Reference flows in litres for three paint scenarios

Scenario	To paint 20 m^2	Repaint 3 times	Paint wastage	Reference flow
Vinyl (Indoors)	2.5	7.5	0.11	7.61
Vinyl (Outdoors)	3.3	10.0	0.15	10.15
Alkyd	3.6	10.9	0.16	11.07

9 Cloverdale Paint, Technical specification data sheet, 593 Series, Waterborne Alkyd Varnish, available online at: http://www.cloverdalepaint.com/info/pdf_tds_ar/60-0080.pdf, accessed May 2014.

10 Sherwin Williams, PROCLASSIC®Interior Waterbased Acrylic-Alkyd, Satin, B33-850 Series, available online at: http://www.sherwin-williams.com/document/PDS/en/035777832301/, accessed May 2014.

11 Lee P., Willis P, WRAP, Paint and woodcare products – distribution and delivery – A review of alternative supply chain approaches within UK paint and woodcare markets, Final Report, 2011.

3.2.3 Life cycle costs of a baseline scenario

3.2.3.1 Cost per litre of paint

The cost per litre of paint is highly variable, depending on the brand, paint range and bulk purchasing discounts. The costs used for the baseline life cycle costing scenario were chosen as the likely cost to the decorating trade for high quality paint; this is shown in Table 2. Also indicated in the table are the ranges of prices that could be expected. Sensitivity analysis on the purchase cost is explored later.

Table 2: Representative costs of purchasing paint per litre for each scenario

Scenario	Range	Representative cost per litre
Vinyl (Indoors)	€3.00 - €12.00	€5.00
Vinyl (Outdoors)	€4.00 - €14.00	€6.00
Alkyd	€9.00 - €25.00	€15.00

3.2.3.2 Disposal costs of waste paint

Discussion with licensed waste disposal operators in the UK revealed that hazardous waste disposal costs approximately €1.10 - €1.90 per litre of solvent-based paint depending on its condition. Water-based paints are much less expensive to dispose of, at approximately €0.15 - €0.65 per litre. Solvent-based paints can therefore be ten times more expensive to dispose of than water-based alternatives (These costs are only representative and depend on factors such as the amount that is disposed of, the distance that it must be transported and the condition of the paint).

Better options for disposal of high quality paints are donation to reuse projects or take-back schemes. The cost of transporting the paint would be the only disposal cost incurred in these cases. Table 3 shows the estimated costs associated with waste disposal for the functional unit of paint. A range of costs has been calculated, representing both the minimum and maximum expected costs for non-hazardous and hazardous waste. The inclusion of the zero cost of disposing of paint through a reuse or take-back scheme is also shown.

Sensitivity to paint wastage rates and disposal costs are explored later.

Table 3: Costs associated with disposal for the paint wastage associated with the functional unit

Scenario	Paint wastage (litres)	Reuse / Take-back	Non-hazardous disposal		Hazardous disposal	
			€0.15 per litre	€0.65 per litre	€1.10 per litre	€1.90 per litre
Vinyl (Indoors)	0.11	0c	1.7c	7.2c	12.1c	20.9c
Vinyl (Outdoors)	0.15	0c	2.3c	9.8c	16.5c	28.5c
Alkyd	0.16	0c	2.4c	10.4c	17.6c	30.4c

3.2.3.3 Baseline life cycle cost

The baseline life cycle cost of fulfilling the functional unit, shown in Table 4, was calculated using the reference flows and the cost assumption discussed above.

It can be seen that there is wide variation in the life cycle costs for each scenario. The cost of fulfilling the functional unit using alkyd varnish incurs more than four times the cost of painting an indoor surface with a vinyl emulsion. The typical use scenario must be considered when comparing the price performance of the different paint types, the alkyd varnish would normally be used to paint smaller wooden surfaces compared with the large surface areas typically covered by outdoor vinyl emulsion paints.

The disposal cost of the waste paint has been shown separately in the table; the costs were calculated at a rate of €0.65 per litre, the maximum estimated cost for non-hazardous waste disposal. This represents a very small proportion of the total life cycle cost; for the baseline scenarios it accounted for between 0.06% and 0.2% of the total cost.

Table 4: Baseline life cycle cost of the functional unit for the three scenarios

Scenario	Reference Flow (litres)	Representa-tive cost per litre	Procurement cost for functional unit	Paint wastage (litres)	Disposal cost	Total cost
Vinyl (Indoors)	7.61	€5.00	€38.05	0.11	€0.07	€38.12
Vinyl (Outdoors)	10.15	€6.00	€60.90	0.15	€0.10	€61.00
Alkyd	11.07	€15.00	€166.05	0.16	€0.10	€166.15

3.2.4 Sensitivity analysis of life cycle cost to performance and cost criteria

3.2.4.1 Cost per litre of paint

The procurement cost of the paint will understandably have a large impact on the life cycle cost of fulfilling the functional unit. This will be demonstrated by showing the sensitivity of the life time cost to the purchase price of the paint. The costs used will be the identified minimum and maximum expected costs shown in Table 2.

Table 5 shows the impact on the life cycle cost of procuring paints and varnishes at the lowest expected procurement price. The life cycle cost falls in line with the price difference, e.g. a 40% price reduction per litre results in a 40% life cycle cost reduction. This demonstrates the dominance of the procurement cost vs. disposal cost for the baseline scenario.

Table 5: Sensitivity analysis to procurement cost, minimum pricing scenario

Scenario	Reference flow (litres)	Life cycle cost	Difference from LCC baseline
Vinyl (Indoors)	7.61	€22.91	-40%
Vinyl (Outdoors)	10.15	€40.70	-33%
Alkyd	11.07	€99.76	-40%

Table 6 shows the impact on the life cycle cost of purchasing at the greatest expected cost per litre.

Table 6: Sensitivity analysis to procurement cost, maximum pricing scenario

Scenario	Reference flow (litres)	Life cycle cost	Difference from LCC baseline
Vinyl (Indoors)	7.61	€91.42	+140%
Vinyl (Outdoors)	10.15	€142.20	+133%
Alkyd	11.07	€276.92	+67%

The actual cost per litre paint may fall outside of the range identified in Table 2.

3.2.4.2 Spreading rate

The baseline reference flow was calculated using the EU Ecolabel values set for spreading rate whilst maintaining the required coverage. Since this represents the minimum standard that needs to be achieved, there is no need to show the sensitivity to inferior spreading rates. Two scenarios for improved spreading rates will be shown: 30% and 50% improvements compared with the baseline.

Table 7 shows that with a modest improvement in spreading rate, that the life cycle costs of fulfilling the functional unit are reduced by 23%.

Table 7: Sensitivity analysis to spreading rates, 30% improvement

Scenario	Spreading rate (litres / m^2)	Reference flow (litres)	Life cycle cost
Vinyl (Indoors)	10.4	5.86	€29.34
Vinyl (Outdoors)	7.8	7.81	€46.92
Alkyd	7.2	8.52	€127.84

Table 8 shows the potential savings obtained by using a paint or varnish with a significantly improved spreading rate. For a 50% improvement in the spreading rate, the life cycle cost improvement over the baseline is 33% for all three types of paint.

Table 8: Sensitivity analysis to spreading rates, 50% improvement

Scenario	Spreading rate (litres / m^2)	Reference flow (litres)	Life cycle cost
Vinyl (Indoors)	12.0	5.08	€25.42
Vinyl (Outdoors)	9.0	6.77	€40.67
Alkyd	8.3	7.38	€110.80

3.2.4.3 Time between repaints

The amount of time between repaints of a surface to maintain the required performance standard is a significant variable in calculating the reference flow of paint over the functional unit. The baseline assumption is that a repaint would be required every seven years, requiring three separate paint applications in order to satisfy the performance criteria over the 21 years stipulated in the functional unit.

There are several GPP criteria that would affect the time between repaints such as the scrub resistance and the weathering resistance. The sensitivity to these criteria will be analysed by investigating the single variable of time between repaints since there would be no distinction in the life cycle costing to which factor was causing the difference.

For the baseline life costing scenario the time between repaints was set at 7 years to maintain consistency with the life cycle assessment work. The functional unit period of 21 years was tailored to the 7 year cycle, thereby requiring the original paint applications and two repaints and thereby fully realising the benefits of the final repaint. For the sensitivity analysis the repaint period will be set at 4 and 10 years, representing a 3-year deviation either way from the baseline. For consistency the functional unit must remain constant despite not being perfectly divisible by the new repaint periods. There are two methods by which this can be compensated for: allow a non-integer number of repaints or strictly account for the number of repaints that would occur in the functional unit time frame. The latter method ignores the full benefit of the final repaint; in the case of the 10-year repaint cycle it would still require three repaints and therefore be identical to the baseline scenario. Given the assumption that the surface to be painted would last longer than the 21 years specified in the functional unit it would be reasonable to allow a non-integer number of repaints to accurately apportion the benefit of the final paint cycle to the functional unit. The non-integer method was used for this sensitivity analysis.3.2.2.

Table 9 shows the worst case scenario for repaint periods: most paints would be expected to satisfy performance criteria up to 4 years. A repaint prior to this would be for aesthetic reasons rather than significant degradation of the paint. The number of repaints required to fulfil the functional unit would be 5.25 and result in a 75% increased cost over the baseline scenario. This scenario would also incur a 75% greater labour cost due to repainting.

Table 9: Sensitivity analysis to repaint periods, 4 year repaint period

Scenario	Reference flow (litres)	Life cycle cost
Vinyl (Indoors)	13.32	€66.74
Vinyl (Outdoors)	17.76	€106.75
Alkyd	19.38	€290.85

Table 10 shows a significantly improved repaint requirement scenario with repaints only required every 10 years; some heavy duty paints could even be expected to exceed this performance. The number of repaints required to fulfil the functional unit would be 2.1 and result in a 30% reduced cost over the baseline scenario. The 30% reduction in cost would also be realised for labour cost since fewer repaints are required.

Table 10: Sensitivity analysis to repaint periods, 10 year repaint period

Scenario	Reference flow (litres)	Life cycle cost
Vinyl (Indoors)	5.33	€26.69
Vinyl (Outdoors)	7.11	€42.70
Alkyd	7.75	€116.34

3.2.4.4 Expected losses due to wastage and disposal costs

Table 4 gave the breakdown life cycle cost assessment and showed that the disposal costs were negligible for the baseline scenario, given the assumption of a 1.5% paint wastage rate and a €0.65 per litre disposal cost.

This sensitivity analysis will explore the two variables in determining the cost of waste: the wastage rate and the disposal costs. The output is expressed in the percentage increased (or in one case decreased) cost over the baseline scenario.

Table 11 shows the sensitivity analysis for both vinyl paint scenarios: the minor differences between the indoor and outdoor scenarios did not warrant being analysed separately. The cost of paint wastage is insensitive to the cost of disposal, but is dominated by the cost of purchasing more paint than is needed to complete the task.

Table 11: Sensitivity analysis to paint wastage, non-hazardous vinyl emulsions

Vinyl	1.5% Wastage	5% Wastage	25% Wastage
€0.15 per litre	-0.1%	3.4%	23.7%
€0.65 per litre	0.0%	3.9%	26.2%

Table 12 shows the sensitivity analysis for the alkyd varnish. This was assessed separately since non-water-based alkyd varnish must be disposed of as hazardous waste which carries a much greater disposal cost. From the figures below it can be seen that the cost associated with paint wastage remains insensitive to disposal cost: a 1,250% increase in the cost of disposal only results in a modest 2.8% increase above baseline costs.

Table 12: Sensitivity analysis to paint wastage, hazardous and non-hazardous alkyd varnishes

Alkyd	1.5% Wastage	5% Wastage	25% Wastage
€0.15 per litre	0.0%	3.5%	23.4%
€0.65 per litre	0.0%	3.6%	24.2%
€1.10 per litre	0.1%	3.8%	24.9%
€1.90 per litre	0.2%	4.0%	26.2%

3.2.5 Conclusion

The life cycle cost of paints and varnishes were established by calculating the baseline cost of fulfilling the functional unit that was set in the life cycle assessment technical work. The life cycle cost considered the procurement cost, the spreading rate, the longevity of the finish and the paint wastage, which included the disposal cost.

It was found that all investigated factors had a large impact on the life cycle cost, with the exception of the disposal cost of waste paint. The majority of the cost from paint wastage occurred due to the additional paint that needed to be procured.

The analysis shows that the procurement cost cannot be considered in isolation and that even moderate improvements in performance can outweigh the additional cost of purchasing more expensive paint. A 20% price increase would, for example, be justified if the paint finish lasted 8.5 years or more compared with the baseline 7 years. Similarly the 20% price increase would be outweighed if a spreading of 9.6 m^2 per litre could be achieved instead of 8 m^2 per litre.

Whilst the quality and cost of the procured paint or varnish were dominant factors in determining the life cycle cost, it is essential to consider the impact of the application and the use phase. Correct cleaning and pre-treatment of the surfaces may significantly extend the life of the painted surface and be a cost-effective step to carry out. Skilled decorators should be able to achieve the advertised spreading rates on suitable surfaces and leave a durable finish that will last a long time, whereas less skilled decorators may use more paint than is necessary and their work may not last as long. A labour cost saving may therefore not result in a life cycle cost saving.

The above described general observations, although done for decorative paints, apply also for road markings, with the durability and the times between repainting/refreshing being determinant in the overall life cycle costing.

4 TECHNICAL ANALYSIS

Information of the environmental performance of paints and varnishes along their whole life cycle is necessary to identify and address where the most significant impacts occur. This section details this information and identifies environmental areas of concerns which should be addressed through the GPP criteria.

4.1 Environmental evaluation and life cycle consideration for paints

Typically, when considering the life cycle of a product (in this case a paint), the production (incorporating material extraction, production and manufacturing), use and final disposal of the product must be taken into account. With regard to paint, the production stage can be well defined and, when analysed in isolation, is termed a cradle-to-gate analysis. This includes all of the impacts associated with the extraction and processing of the materials, formulation of the paint, packaging and shipping prior to use.

Within paint's use-phase, its performance during application and in use is critical. It affects the amount of paint needed to cover a surface and also the number of repaints necessary with a set time frame. These two effects have an impact on the amount of paint required and therefore the production phase of the LCA. Also within the use-phase is the direct release of emissions to the environment during painting and whilst in use.

At the end of life, the following aspects need to be addressed:

- What amount of paint stays unused? This is important because it can have an impact on the overall performance of the paint and needs to be accounted within the performance characteristics. It also has its own environmental impact because it enters the waste stream for recovery or disposal.

- The fate of packaging material.

- The fate of the painted surface when it last reaches its end of life phase (e.g., end of life of the building), at which point the paint will enter the waste stream with that substrate or building material. In general the fate of the building material is more important in the environmental analysis than the fate of the paint itself (also due to allocation of the environmental impacts based on the weight ratio of paint/building component), though the presence of the paint might alter the alternative fates available to the substrate.

4.1.1 Review of available life cycle assessments for paints

Seven separate paint life cycle assessments (LCAs) were identified and analysed. This section details their findings and comments on their suitability for determining the environmental 'hotspots' of paint for the Green Public Procurement.

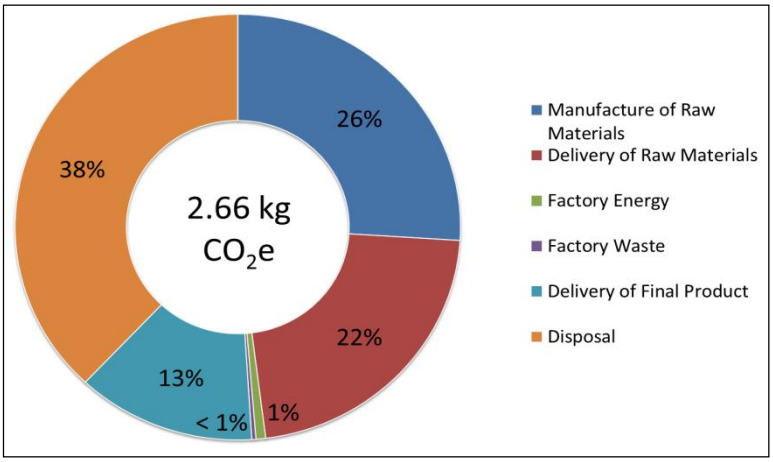
A study by the Swedish Paint & Printing Ink Makers' Association (Sveff)[12] examined three different paint formulations: a solvent-based varnish, a powder paint and a solvent-based alkyd. It examined the impact of paint production on greenhouse gas (GHG) emissions, low-level ozone, acidification and eutrophication. They found that, for solvent-based paints, the main constituents (solvent, binder and pigment) shared the environmental impact equally. Any surface treatment that extended the

12 Sveff, Lifecycle assessment of paint: Summary of IVL Report B 1338-A, 2004.

life of a product contributed most to the environmental benefit of the paint. The impact of transportation was negligible.

In 2007, dcarbon8 performed a detailed carbon footprint for Jotun Paints for five of their products.[13] Two key findings emerged from the analysis. The first was that the carbon footprints of solvent-based paint systems were approximately three times greater than those for a corresponding water-based paint. This was due to the added environmental cost associated with the production of the solvent compared with the relatively low costs associated with water. The second important finding was that the impact of end of life was significant: for water-based paints, where the environmental impact was relatively low, the impact of disposal at end of life could reach 38% of the total environmental impact of the paint. However, some caution should be taken with this figure because 'end of life' was imprecise within the report and may include normal manufacturing processes. Figure 3 shows the breakdown of impacts by life cycle stage for one of the paint products that was investigated.

Figure 3: Breakdown of carbon impact by life cycle stage for Jotashield Alkali Resistant Primer



Source: Adapted from the dcarbon8 report

A comprehensive study[14] by VTT Building Technology examined the environmental impact of exterior coating systems. They examined coated wooden cladding over a period of one hundred years including:

- manufacture of raw materials for paint;
- manufacture of paints;
- transports;
- painting;
- care and renewal;
- recycling and final disposal.

13 dcarbon8, Jotun Paints – Product Life Cycle Assessment, 2007.
14 VTT Building Technology, Environmental Impact of Coated Exterior Wooden Cladding, 1999.

Thirteen model paints were analysed (see Table 13). The study is comprehensive and is declared as complying with the now out-dated ISO 14041 standard for performing life cycle assessment. As part of the collection of data, major paint manufacturers were surveyed and, although these are comparatively old data (from the late 1990s), some of the model paints appear to be in use still today.

Table 13: Paint formulations examined by VTT

Formulations	Solvent (mineral spirit or water)	Binder	Pigment	Extenders ($CaCO_3$)	Additives
Alykyd (tall oil)					
1 SB priming oil	90%	10%			
2 SB undercoat	45%	25%	10% TiO_2	20%	
3 Factory primer	65% H_2O	10%	15% TiO_2	10%	
4 WB priming oil	90% H_2O	10%			
5 SB stain	77%	20%	3% iron oxide		
6 WB stain	77% H_2O	20%	3% iron oxide		
7 Opaque topcoat	20%	40%	20% TiO_2	20%	
Linseed oil					
8 Primer	20% (turpentine)	50%	30% ZnO		
9 Opaque topcoat		45%	15% ZnO 15% TiO_2	15% 10% talc	
10 Opaque topcoat		45%	30% yellow ochre 15% ZnO	10%	
Acrylic dispersion					
11 WB stain	77 – 82% H_2O	17.5%	3% iron oxide		
12 Opaque topcoat	50% H_2O	25%	15% TiO_2	10%	
Other					
13 Swedish red paint	66% H_2O	8% rye 6% linseed oil	16% Falu red pigment		4% iron sulphate

Source: Adapted from the VTT report

The study examined the whole life cycle of the painting system including in-use data such as cleaning, repainting and the impact of the wood itself.

From this study, it was concluded that:

- Fillers (e.g., calcium carbonate or talc), pigments (e.g., ferric oxides, red or yellow ochres) and additives (e.g., ferric sulphate) provide only a minor contribution to the environmental burden of the paints.

- The organic solvent is responsible for the majority of impacts in paints, where there is a high content of white spirit (particularly in priming oils and stains). The environmental burdens (emissions and use of resources) are typically one third less in the corresponding water-borne products having alkyd as the binder.

- The environmental burdens of acrylate stains are roughly double compared with water-based alkyd stains.

- Solvent-based paints lead to a ten-fold increase in VOC release in use compared to water-based alternatives.

- The impact of titanium dioxide dominates for paints with a titanium dioxide concentration of 10% or greater.

- Manufacturing process was estimated at 10% of the total environmental burden.

An investigation of the lifetime of the product showed that the frequency of repainting had a proportional effect on the overall impact – an increase of three years in periods between repainting resulted in a 15% decrease in energy consumption.

A 1993 study by Ecobilan[15], which was the basis for the development of the initial EU Ecolabel paints and varnishes study, assessed the environmental impact of 11 different paint formulations (Table 14). The information was provided by paint manufacturers. To remove performance variation and provide a fair comparison between paints, the study defined the functional unit as the amount of paint that is needed to cover a 20m^2 area to a 98% opacity.

Table 14: Paint formulations for the Ecobilan study

	Paint type	Solvent medium	Binder	Solvent type	Quantity of paint required for functional unit (litres)
A	**Matt**	Water	Styrene-acrylate		2.47
B	**Glossy**	Water	Styrene-acrylate		2.08
C	**Semi-glossy**	Solvent	Alkyd	White spirit >5%	1.90
D	**Glossy**	Solvent	Alkyd	Isoparaffin	1.96
E	**Matt**	Solvent	Styrene-acrylate	Isoparaffin	2.99
F	**Glossy**	Solvent	Alkyd	Isoparaffin	1.77
G	**Glossy**	Solvent	Alkyd	White spirit >1%	1.77
H	**Matt**	Solvent	Linseed oil	Isoparaffin	3.13
I	**Matt**	Water	Linseed oil emulsion		2.94
J	**Glossy**	Solvent	Alkyd (high content of solid matter	White spirit >1%	1.163
K	**Matt**	Water	Styrene-acrylate (micro-voids)		2.17

Source: Adapted from the Ecobilan study

It was concluded that:

- the TiO_2, binder and solvent contributed most to the environmental impact of the paint,;

- transport has a very low impact on the environmental impact of paints;

15 European Ecolabel project for application to Paints and Varnishes, Volume 5, results of the extension phase, The Life Cycle, Analysis of eleven indoors decorative paints, ECOBILANCOMPANY, 1993

- water-based paints' environmental impact was less than those with organic solvents.

The comprehensive LCA database, Ecoinvent, contains three LCA datasets (covering the life cycle from cradle-to-gate) referring to paints:

- acrylic varnish, 87.5% in H_2O;
- alkyd paint, white, 60% in H_2O;
- alkyd paint, white, 60% in solvent.

The data on product composition was taken from European manufacturers.[16] The data for each of the individual components within the product process, such as electricity and chemicals, were updated via the Ecoinvent database. However, it should be highlighted that the paint formulations are relatively old (pre-1995) and not representative of the current market.

Results from the Ecoinvent LCAs broadly follow the results detailed in the other studies in this review. The binder and TiO_2 were the largest contributors to the environmental impact. Solvent also played an important role within the LCA of alkyd paint in solvent. Interestingly, the environmental burden of growing and producing soya oil for the alkyd paints produced different, but not necessarily less, environmental impact than corresponding synthetically produced binders. This meant that the impact of producing biologically derived binders were important within the LCA.

Summary

Based on the review of the identified LCAs described above, the following conclusions can be made:

- Solvent-based paints have a higher environmental impact than corresponding water-based paints.
- Extending the life of a product contributed most to the environmental benefit of the paint.
- The impact of transportation is negligible.
- The lack of inventory data on paint fillers, pigments and additives meant that the assessment of the environmental impact of these components is largely incomplete.
- Solvent-based paints can lead to a ten-fold increase in the release of VOCs compared to water-based paints.
- Where more than 10% TiO_2 is used, it is the most significant contributor to the environmental impact.
- Manufacturing impacts were vague within all examined studies.

16 Danken A and Chudacoff M., Vergeichendeokologische Brewertung von Anstrichstoffenim Baubereich, 1995.

4.1.2 Life cycle assessment of a paint

In addition to the information currently available from the references, a cradle-to gate LCA was performed using the Ecoinvent database to identify environmental 'hotspots', particularly for paint ingredients. The initial goal was to perform a simplified LCA which could provide sufficient data to identify where environmental impacts of paint manufacture are. This section focuses on presenting the main environmental impact of the production phases of paint and final disposal of unused paint determined in this analysis. For the details of the LCA conducted please consult the Green Public Procurement Background Report from July 2012 available at the project website.[17]

4.1.2.1 Selection of paint

A key difficulty in defining the environmental impact of a paint is that there is no 'standard' paint formulation. One on-line paint product directory contains 10,000 different resin/polymer formulations, 9,000 additives and 4,500 pigments and fillers.[18] This large number of different ingredients can be used in a variety of combinations giving rise to hundreds of thousands of different paint formulations. Clearly, assessing the environmental impact of all varieties of paints is impractical and a representative sample of products is needed.

Information provided within the PRODCOM database identified two paint types with the largest market share:

- **Water-based vinyl emulsions** which can be used for a diverse range of paint applications from wall paints and trim paints,
- **Water-based Alkyd emulsions** that are largely used in varnishes.

The BoM for the two sample paints are presented in Table 15 and Table 16. Based on the market analysis conducted in the framework of this project[19], these two paints represent approximately 50% of the entire European market share of paints.

The **functional unit** for this life cycle assessment was chosen to be the amount of paint required to cover a 20 m^2 surface for a period of 21 years, assuming that a repaint is required every 7 years to maintain coverage.

Table 15: Bill of materials for 1 kg of vinyl emulsion wall paint

Material	Amount (g)
Water	326
Binder: butyl acrylate	144.1
Binder: methyl methacrylate	117.9
Titanium dioxide	120
Filler (calcium carbonate)	272
Other additives (biocides, surfactants and defoamers)*	20

*These additional ingredients vary significantly on the type of paint used. Defining a paint formulation that is representative is not possible for these minor ingredients.

17 Green Public Procurement Background Report, available online at: http://susproc.jrc.ec.europa.eu/paints/docs/GPP%20Paints%20Background%20Report%20FINAL.pdf., July 2012.

18 SpecialChem4Coatings.com (website dedicated to Coatings and Inks formulation), http://www.specialchem4coatings.com/ .

19For details, see the section on Market Analysis in the Technical background report available at http://susproc.jrc.ec.europa.eu/paints/stakeholders.html.

Table 16: Bill of materials for 1 kg of alkyd emulsion paint

Material	Amount (g)
Titanium dioxide	250
Alkyd emulsion: propylene glycol	90
Alkyd emulsion: phthalic anhydride	90
Alkyd emulsion: linoleic acid	120
Metal drier 8% colbalt solution	4.5
Thickener (organo-clay)	32
Additives (defoamer, biocide, dispersant)*	12.5
Water	401

* These additional ingredients vary significantly on the type of paint used. Defining a paint formulation that is representative is not possible for these minor ingredients.

4.1.2.2 Analysis and comparison

The impact assessment was performed using the IMPACT 2002+ method. IMPACT 2002+ is a combination of four methods: IMPACT 2002 (Pennington et al. 2005), Eco-indicator 99 (Goedkoopand Spriensma, 2000, 2nd version, Egalitarian Factors), CML (Guinée et al. 2002) and IPCC. The data referred to the production of 8.25 kg of the respective paints; this is the reference flow required to fulfil the functional unit including 10% wastage.

4.1.2.2.1 Manufacturing

Table 17 and Table 18 detail various environmental impacts of the production of the two model paints and the disposal scenario. This view provides an overview of total paint impacts. The overall environmental impacts (single score) of producing both paint types are within 10% of each other. Due to any inaccuracies associated with the modelling, these differences are within the bounds of error and suggest that the overall effects of the manufacturing processes for these two paints are equivalent. Damage to the ecosystem caused by the alkyd emulsion paint is significantly higher than that caused by the corresponding vinyl paint. This is the only noticeable difference between the two products and is due to the sourcing, harvesting and processing of soya oil for linoleic acid. This can be balanced against the higher impacts on human health and energy for the completely synthetic paint (vinyl emulsion).

Furthermore, the analysis revealed that three biggest contributors to the environmental impact of paint production are: **binders, TiO2 pigment** and paint plant **energy in production/formulation**. This mirrors the evidence provided by the LCAs review. About one quarter of the overall environmental impact of the paint is from the paint manufacturer (operating formulation plant), while the remaining 75% of the impact is within the paint manufacturer's supply chain.

A reduction in the amount of TiO_2 used could produce a significant reduction in the environmental impact of the paint. The environmental impact of TiO_2 production was modelled based on a 50:50 mix of material produced via the sulphate process and chloride process. As can be seen from the breakdown of the emissions from these two manufacturing routes, the environmental impacts are similar, with the sulphate route being slightly more environmentally damaging than the corresponding chloride route. Based on this analysis there is an argument that the EU Ecolabel could encourage more use of chloride-derived TiO_2. The formulation of the vinyl paint uses calcium carbonate filler in place of some of the TiO_2. This has reduced the impact of this paint meaning the contribution to the overall impact from TiO_2 is roughly half that of the corresponding alkyd paint.

Table 17: Results from a simplified impact assessment on human health and ecosystem for the production of two model paint systems for the functional unit.

Human Health / DALY			
	Vinyl emulsion wall paint	**Alkyd emulsion paints**	**Disposal**
Carcinogens	8.83E-07	6.77E-07	2.80E-08
Non-carcinogens	4.15E-07	7.10E-07	1.33E-07
Respiratory inorganics	9.32E-06	1.10E-05	3.36E-07
Ionizing radiation	4.79E-08	8.91E-08	3.06E-09
Ozone layer depletion	1.72E-09	2.64E-09	2.12E-10
Respiratory organics	2.86E-08	1.96E-08	7.24E-10
Total	**1.07E-05**	**1.25E-05**	**5.01E-07**

Ecosystems / PDF.m2.yr			
	Vinyl emulsion wall paint	**Alkyd emulsion paints**	**Disposal**
Aquatic ecotoxicity	5.12E-02	5.71E-02	2.86E-03
Terrestrial ecotoxicity	1.51E+00	2.73E+00	8.48E-02
Terrestrial acid/nutri	3.06E-01	4.00E-01	1.13E-02
Land occupation	7.58E-02	4.49E+00	5.30E-03
Total	**1.95E+00**	**7.67E+00**	**1.04E-01**

Table 18: Results from a simplified impact assessment of resource consumption and single score for the production and disposal of two model paint system for the functional unit.

Resources / MJ Primary			
	Vinyl emulsion wall paint	**Alkyd emulsion paints**	**Disposal**
Non-renewable energy	4.26E+02	4.06E+02	1.64E+01
Mineral extraction	2.66E-01	3.47E-01	8.78E-03
Total	**4.26E+02**	**4.07E+02**	**1.64E+01**

Single Score / Pt			
	Vinyl emulsion wall paint	**Alkyd emulsion paints**	**Disposal**
Human Health	1.51E-03	1.76E-03	7.07E-05
Ecosystem quality	1.42E-04	5.60E-04	7.62E-06
Climate change	2.02E-03	1.93E-03	1.89E-04
Resources	2.80E-03	2.67E-03	1.08E-04
Total	**6.47E-03**	**6.92E-03**	

A wide variety of binders is used, producing a range of properties that can be tailored to suit the performance needs of the paint. Binders include:

- Alkyds;
- Cellulose;
- Bitumens;
- Epoxies;
- Acrylics;
- Vinyls;
- Polyurethanes.

Where possible, limiting the use of binders would reduce the overall environmental impact of the paint (assuming a similar performance can be achieved). Where a choice of binders could be used, it is conceivable that a requirement could be set to use those which are less environmentally damaging. However, due to the wide variety of properties and uses dictated by the choice of binder, analysis on a case-by-case basis would be necessary to determine the most appropriate binder. This data does not exist and any research would only be valid for that particular application. With additional primary research, it would be possible to rank the environmental performance of all binder systems, but prescribing the binders used would be impractical within the GPP criteria because of the requirement for particular properties in the final product.

Some aspects of the environmental damage of the binder can be assessed. The hazardous nature of some of the binders and, in particular, some of the binder precursors are addressed through the hazardous substances criteria.

4.1.2.2.2 Use phase

Paint application and durability

Conclusions from the LCAs reviewed denote that the amount of paint used and the lifetime of the paint are important when considering their environmental impact.

A performance of paint can be investigated based on the following:

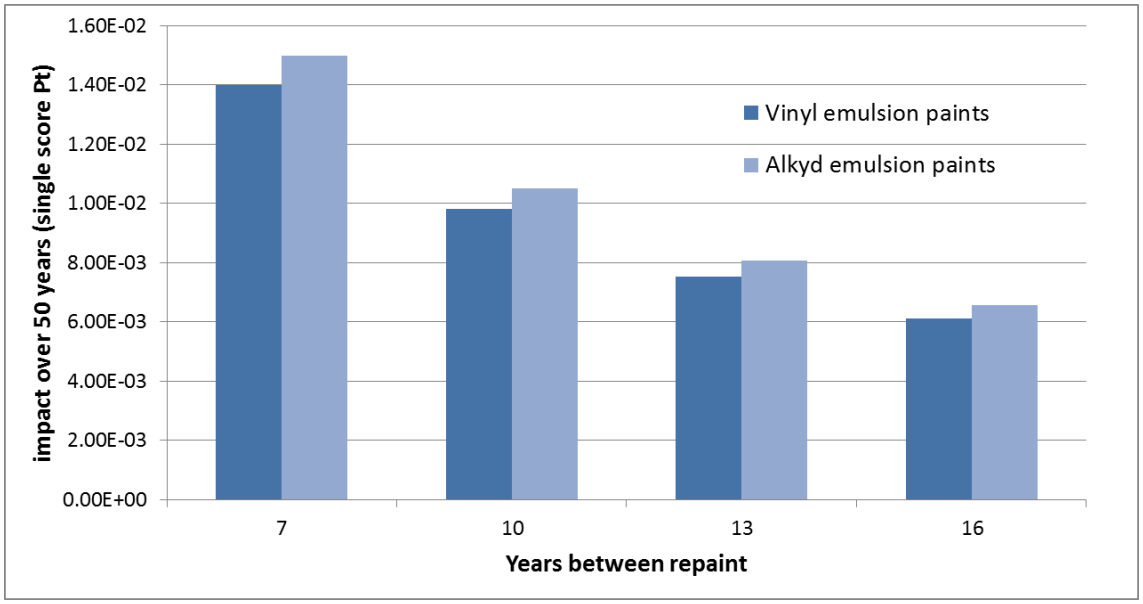
1. The overall amount that is necessary to use for painting a certain surface (and reach a predefined painting quality) and;
2. The time that is needed until the next repaint.

Paint with good performance characteristics will need to be used in smaller amount and afterwards the painted surface will require less frequent repaints. As a consequence, using a smaller amount of paint results in a lower environmental impact related to the paint production, along with the release of air pollutants during application and the treatment of waste.

The effect of the lifetime of the use phase of the paints can be illustrated by examining the period needed between repaints. Figure 4 depicts the environmental benefits from increasing the performance of the paint resulting in increased periods between repaints. It shows the impact of covering 20 m^2 of wall with 2.5 kg of paint over a 50 years' timeframe.

The "base case" assumes 7 years between repaints. It should be noted that this model does not account for consumer behaviour; for example the investigation for the EU Ecolabel for buildings revealed that a major renovation takes place approximately every 15 years.

Figure 4: The effect on the environmental impact of improving performance and increasing time between repaints.



Decreasing the frequency between repaints has a significant effect on reducing the environmental impact of the paint. A relatively minor increase in paint performance can lead to a significant reduction in the overall impact of the paint (over the modelled 50 year lifetime). In the example

above, although there is a 7% difference in the environmental burden of the vinyl and alkyd emulsion paint, this is dwarfed by the savings made through the reduction in environmental burden by increasing the period between repaints. Even based on this simple approximation the importance of including **performance criteria** of paints seems to be evident.

4.1.2.2.3 Hazardous substances

In the LCA performed a cut-off limit of 5% w/w of the final paint was applied, which largely included the "additives" portion of the BoM. It is difficult to determine a representative assessment of the additives due to the large number of different chemicals that could be considered in this category and the diversity of their environmental impact. In order to overcome this limitation an investigation on some of these chemicals which are of concern to the environment and human health are discussed here. Of particular concern is the emission of hazardous and eco-toxic chemicals, both during production and during the application and use of the paint.

This section tries to highlight a limited number of chemicals which are considered to be of particular concern within the paints industry and for the environmental schemes. A large number of traditional paint ingredients are toxic or harmful. It is not the intention of this section to identify every chemical which may be of concern but to investigate further and assess the environmental importance of taking an action within the GPP policy for the chemicals that have been highlighted through regulatory control and are of special importance for the stakeholders who participated in the criteria development process. These chemicals are currently addressed within the latest revision of the EU Ecolabel paints and varnishes criteria which were voted in November 2013.

The concern for these chemicals is centred on their emission and associated impacts in the paint's use phase and their release, rather than on their production. Several of the identified chemicals of concern and their influence on the environment or human health are briefly described below.

Alkylphenolethoxylates (APEOs)

APEOs are non-ionic surfactants, which have an emulsifying and dispersing effect when processing paints, and in binders, **dispersion** aids, thickeners, driers, antifoam agents and pigment pastes.[20] APEOs are produced in large volumes, with uses that lead to widespread release to the aquatic environment. They are highly toxic to aquatic organisms, and in the environment degrade to more environmentally persistent compounds. These chemicals have been detected in human breast milk, blood, and urine and are associated with reproductive and developmental effects in rodents.[21]

Perfluorinated alkyl sulfonates (PFAS)

PFAS is the collective name for a group of fluorinated surfactants. Similar to APEOs, these are used in dispersants, thickeners, driers and pigment pastes. Of particular concern is perfluorooctane sulfonate (PFOS), which has been analysed in a limited number of European environmental and food samples and has been shown to bio-accumulate in fish. This bio-accumulation seems to be an important source of human exposure to PFOS.[22]

Following absorption, PFOS is slowly eliminated and therefore accumulates in the body. PFOS shows moderate acute toxicity. In sub-acute and chronic studies the liver was the major target organ and developmental toxicity was also seen. Other sensitive effects were changes in thyroid hormones.[23]

20Nurmi T., Kanniainen K., Paints and how they affect the environment, 2008.

21U.S. Environmental Protection Agency, Nonylphenol (NP) and NonylphenolEthoxylates (NPEs) Action Plan, 2010, available online at: http://www.epa.gov/oppt/existingchemicals/pubs/actionplans/RIN2070-ZA09_NP-NPEs%20Action%20Plan_Final_2010-08-09.pdf, accessed May 2014.

22Scientific Opinion of the Panel on Contaminants in the Food chain, European Food Safety Authority, Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and their salts, 2008.

23European Food Safety Authority, Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and their salts, Scientific Opinion of the Panel on Contaminants in the Food chain, 2008.

Formaldehyde

Formaldehyde donors are used as a biocide in water-based paints (particularly protecting the head-space within the paint pot). Formaldehyde can cause irritation of the skin, eyes, nose, and throat. High levels of exposure may cause some types of cancers; for example, some studies of people exposed to formaldehyde in the workplace found more cases of cancer of the nose and throat than expected. In animal studies, rats exposed to high levels of formaldehyde in air developed nose cancer.[24] Formaldehyde is often used as proxy, a reference indicator for other similar chemical structure substances which are not covered in the life cycle impact assessment models (no characterisation factor determined).

Halogenated organic solvents

A halogenated solvent is an organic solvent, molecules of which contain halogens: chlorine (Cl), fluorine (F), bromine (Br) or iodine (I).[25] They can be found in the paint industry in thinners, strippers and solvents. They are used as they are largely non-flammable, though if they do combust they can produce toxic gases. Risk to health from using halogenated organic solvents in paint includes dermatitis and eye irritation. More serious exposure via vapours or high levels of the solvents can lead to kidney and liver damage, heart irregularities, and they are potentially carcinogenic.[26]

Phthalates

Phthalates are commonly found in PVC where they are used as plasticisers, giving the plastic desired physical properties. They can be also used in paints to alter the overall finish of the paint. Several phthalates have been shown to be endocrine inhibitors; this can cause cancerous tumours, birth defects, and other developmental disorders. Some phthalates are in the candidate list to be classified as Substances of Very High Concern (SVHC). Opinion on other is not unanimous. Stakeholders along the consultation process pointed out that in 2014 Denmark notified the ECHA with a proposal for harmonised classification of DINP as category 1B reprotoxicant[27]. Also other sources indicate endocrine disrupting activity of phthalates like DIDP and DINP[28], which would support introducing a restriction on DINP and DIDP in the GPP criteria for paints and varnishes. Such a restriction is not included in the current EU Ecolabel criteria. At present, both tools are aligned with regard to phthalates. It is proposed to keep the potential inclusion of DINP and DIDP for consideration in the next revision when the ECHA evaluation is also finalised.

Heavy metals

In large quantities, heavy metals are considered carcinogenic and hazardous to human health.[29] Although present in the environment, and necessary for human health in small amounts, any large concentration can cause acute or chronic toxicity.[30] As they are elements, they cannot be broken down and therefore will persist in the environment.[31] When absorbed by humans, they have been shown to have detrimental effects on kidney function, reproductive organs and the nervous system,

24Agency for toxic substances and disease registry, Formaldehyde Factsheet, 1999, available online at: http://www.atsdr.cdc.gov/tfacts111.pdf, accessed May 2014.

25 Kopeliovich D., Classification of Solvents, Substances & Technologies website, available online at: http://www.substech.com/dokuwiki/doku.php?id=classification_of_solvents, accessed May 2014.

26 Childs B., Eckmann A., Plasma Science and Fusion Centre, Office of Environment, Safety, and Health, Massachusetts Institute of Technology, Standard Operating Procedures for Use of Halogenated Solvents and Products Containing Halogenated Solvents, available online at: http://www.psfc.mit.edu/esh/halosolv.html, accessed online May 2014

27 See http://echa.europa.eu/registry-current-classification-and-labelling-intentions/-/substance-rev/4917/term.

28 Chen X., Xu S., Tan T., Lee S.T., Cheng S.H., Lee F.W., Xu S.J., Ho K.C., Toxicity and estrogenic endocrine disrupting activity of phthalates and their mixtures, US National Library of Medicine, Int. J. Environ. Res. Public Health. 2014; 11(3):3156-68, available online: http://www.ncbi.nlm.nih.gov/pubmed/24637910, accessed 10.10.2015..

29 Air Pollution Information System website, Heavy Metals, available online at: http://www.apis.ac.uk/overview/pollutants/overview_HM.htm, accessed May 2014

30 http://www.lef.org/protocols/prtcl-156.shtml

31 http://www.apis.ac.uk/overview/pollutants/overview_HM.htm

particularly in unborn infants and young children. The use of some of these metals is now subject to regulation from REACH which came into effect on 1 June 2007.[32]

Cadmium: Cadmium is used as a colorant in paint pigment[33] and levels are controlled by EU regulations except in the use of certain items coloured for safety reasons.[34] Paint that contains a level of cadmium (as a pigment) higher than 0.01% by mass is prohibited. If the paint contains a high level of zinc, the residual concentration of cadmium must be as low as possible, in any case not higher than 0.1% by mass.[35]

Lead: Lead-based paints were banned for sale for use by the general public in the EU in 1992[36], although some specialist uses for industry and the military are still permitted. Lead had originally been used in paint as a pigment and drying agent. White lead was predominantly used as the white pigment in primer type paints. The lead-based pigments (lead tetroxide/calcium plumbate, or "red lead") were used as an anti-corrosive primer agent in paint used on metal[37.] Nowadays the exposure to, or removal of, old leaded paint can still present a hazard to human health.

Chromium VI: This is a group of compounds which has a low (acid) or neutral pH. Zinc, lead and calcium chromates form the most important compounds in the group. Calcium chromates are rarely used in paints nowadays. Zinc chromates are often used in primer paints as they have high anti-corrosive properties.[38] Lead chromates are used in topcoat paints and occasionally in primer paints.[39]Cr II is an unstable compound and therefore little used in paint. Cr III is used in paints as a green pigment or as a protective coating on metals (anti-corrosive).It may cause some respiratory difficulties or skin reactions but is not considered highly harmful.

Use of lead chromate pigments in paints and coatings, in road markings and sign paints is being phased out in Europe under the REACH Regulation[40]. Nevertheless, REACH allows companies to apply for an Authorisation for use of these pigments in specific end-uses for which no reasonably substitutes were found. According to information from the British Coatings Federation (BCF) which looked the regulatory side for road markings[41]"*There has been an Authorisation Application to argue for the continued use of two lead pigments in industrial paints (for use on machines, vehicles, structures, signs, road furniture, etc.) or as road marking. The British Coatings Federation (BCF) has opposed the Application on the grounds that, as there are many alternatives to these pigments on the market, they can be substituted. It is appreciated, however, that none of these alternatives give completely the same properties as lead pigments and some changes will have to be made by applicators. The vast majority of BCF industrial coatings members, large and small, have moved, or want to move away from lead, and are ready to use alternatives, as long as there is a level playing field and any ban is properly policed. Of course some of the multinationals have already moved or committed to move away from lead globally, and in Australia (for example), all lead paints are banned".*

32 http://www.hse.gov.uk/foi/internalops/fod/oc/200-299/253-11.htm
33 HSE, web leaflet INDG391(rev1), revised 03/10
34 http://eur-lex.europa.eu/LexUriServ/site/en/oj/2007/l_136/l_13620070529en00030280.pdf
35 www.cbi.eu/?pag=85&doc=416&typ=mid_document
36 Marketing and Use Directive (89/677/EEC) through the Environmental Protection (Controls on Injurious Substances) Regulations 1992 (Statutory Instrument 1992/31)
37 http://www.rsc.org/chemistryworld/News/2007/August/21080701.asp
38 HSE Information Sheets: Chromate Primer Paints, engineering sheet number 32
39 HSE Information Sheets: Chromate Primer Paints, engineering sheet number 32
40 Regulation EC 1907/2006 on the Registration, Evaluation, Authorisation and Restriction of Chemicals
41Wayne Smith, from the British Coatings Federation (BCF),

Mercury: In the past, phenyl mercuric acetate was commonly used as a fungicide in water-based latex paints, to prevent the growth of bacteria.[42] Its use in paint was banned in the USA in 1991.[43] In the UK, paint companies have voluntarily removed mercury from paints, though its use is still legal.

Arsenic: Arsenic is well known for its poisonous properties. It is not used in paint production today, although traces may rarely still be found in green paint pigment, particularly on artists' frescoes or canvases.

Barium: Synthetic barium sulphate is used as a filler in the paint and varnish industry and can also be an element in white pigment. Its inertness and high density qualities make it useful to improve the consistency and handling properties of paint.[44]

Selenium: Selenium is normally extracted as a by-product of copper production.[45] One of the main applications for selenium is for pigmentation in glass manufacture to colour and decolourise glass, and also in paint, which comprises approximately 40% of the selenium demand. It is used in the photovoltaic industry and demand is therefore predicted to rise in the future.[46]

Antimony: This metal is found in paint pigments, as well as in batteries, ceramics and glass.[47] It was initially used by make-up artists for black face paint, known as 'kohl'. Nowadays it is valued in paint for its flame-retardant properties.[48]

Volatile aromatic hydrocarbons (VAHs)

VAHs include compounds such as benzene[49], toluene and benzaldehyde, and are used as solvents in paints. They can have severe effects on the human body and the environment including having an effect on the reproductive system and carcinogenic.

Volatile organic solvents (VOCs)

VOCs are used as solvents within paints to help keep them stable prior to use and to aid in spreading and delivery of the paint to the substrate. VOCs encompass a wide variety of compounds and are generally classed as organic substances with a boiling point less than 250°C.[50] VOCs generally evaporate or sublimate from the paint during and after application. The release of these emissions can cause eye, nose, and throat irritation along with headaches and loss of co-ordination. There is a diversity of compounds encompassed by this classification, and more extreme reactions can also present, in particular: damage to liver, kidney, and central nervous system and some are suspected or known to cause cancer in humans.[51]

Isothiazolinone compounds

Isothiazolinone compounds are found in wood coatings[52]and in some paint formulations. They are a broad spectrum fungicide, algicide and bacteriostat used in solvent-based coatings, surface protection products and other xylene-compatible products.[53] For people susceptible to their effects,

42 UNECE, www.unece.org/.../TFHMs_3.ProductsReviewChapter.draft.05.04.06
43 http://www.epa.gov/hg/consumer.htm#pai
44 http://www.nanopartikel.info/cms/Wissensbasis/Bariumsulfat
45 http://www.mmta.co.uk/metals/Se/
46 Minor Metals Trade Association, Selenium
47 http://www.lenntech.com/processes/heavy/heavy-metals/heavy-metals.htm
48 Minor Metals Trade Association, Antimony
49 Preventing disease through healthy environments, Exposure to benzene – a major public health concern, WHO, available at: http://www.who.int/ipcs/features/benzene.pdf.
50 Directive 2004/42/CE
51 http://www.epa.gov/iaq/voc.html
52 Revision of European Ecolabel and Development of Green Public Procurement Criteria for Indoor and Outdoor Paints and Varnishes, October 2011
53Akcros Chemicals, http://www.akcros.com/products/europeproductrange/productsbycategory/microbiocides.aspx

the compounds can cause irritation to the skin and mucous membranes.[54] The extent to which they do this depends greatly on the level of concentration in the product used and the method of exposure.[55]

4.1.2.2.4 End of life phase

The environmental impacts associated in the end-of-life phase of the paint, as modelled in the streamlined assessment, is low compared to impacts in the production and manufacturing phase. This end-of-life phase, however, only models the impacts related to the processes involved in the incineration of the paint (and their associated environmental impacts). The environmental impacts associated with the production of the paint residuals are not expressly incorporated within the end-of-life phase of the current model (they are incorporated, but not highlighted, within the production phase).

The unused paint has a significant environmental impact and it is therefore important to further investigate (including the impact of production). As mentioned above, there is significant debate over the average amount of paint wasted during application, with the current streamlined assessment assuming a conservative 10% level of wastage. A recent study of WRAP[56] highlights the problem of unused paint in the UK. In the domestic market, an estimated 25% of all paint goes unused, whereas wastage in trade use is 1.5%. Scaling up to Europe, this equates to approximately 900,000 tonnes of unused paint wasted every year, suggesting that approximately 12% of the environmental burden of paint is from wasted paint.

Stakeholders provided information that the amount of unused paint from professional application, i.e. also public procurement, is lower than in the private sector. According to their experience 1.5% value shall be representative. Thus the assumption used in the study may be too high. Information for cross-checking of this value is however very scarce and difficult to verify.

In any case, any reduction in the amount of unused paint would have a significant reduction on the environmental impact of the paint and paint industry. Possible methods to achieve this reduction include:

- The sale of appropriate quantities of paint using different sized tins or bespoke dosing systems or correctly conveying the amount of paint required by the user to prevent over-ordering.
- Where paint is not needed, the appropriate reuse (where possible) will also reduce the environmental impact.
- Take-back schemes are available (usually run by the charitable sector) that could limit wasted paint.

The development of take-back schemes for paints has also seen a recent increase. Crown Paints, for example, is the UK's largest independent decorative paint manufacturers and has recently promoted a scheme which allows trade customers to return used Crown paint cans to store when they purchase new paint. A 'can-back' scheme has also been piloted where used paint containers are collected at Crown retailers and either reused or recycled back into the supply chain for the

54 Consumer exposure to biocides - identification of relevant sources and evaluation of possible health effects, Stefan Hahn, February 2010

55 Consumer exposure to biocides - identification of relevant sources and evaluation of possible health effects, Stefan Hahn, February 2010

56Lee P., Willis P, WRAP, Paint and woodcare products – distribution and delivery – A review of alternative supply chain approaches within UK paint and woodcare markets, Final Report, 2011.

production of new paint containers. The process of granulating and recycling of used plastic paint containers is also being introduced on a larger scale by Crown paints.[57]

A variety of other companies also run schemes through which unwanted paint can be returned to the supplier. For example, Paint+, which operates across the UK, takes back unused paint free of charge to be sold or donated.[58]There are also a number of charitable organizations who collect unwanted paint and use it in community projects.[59]Further schemes operate overseas, for example CalRecycle operates a paint reuse facility in California.[60]

An additional problem is that waste paint can be considered a hazardous material and therefore disposal should be appropriately controlled.

Used paint pots present a recycling challenge as they invariably contain leftover paint inside. It appears that the composition of paint pots (both steel and plastic) enables them to be readily recycled. However, containers are very unlikely to be in a sufficiently clean condition for this to be achieved. In general in the UK, spent paint pots are sent to landfill[61]with efforts directed towards the reuse of left over paint rather than the recycling of the pots.[62]

Recycling of paint pots does appear to be possible in the trade sector but requires specialist equipment and is not suitable for the DIY market.[63] The recovery of energy appears to be a favoured route to dispose of plastic paint pots, for example using them as cement kiln furnaces for fuel.[64] Metal containers are mainly recovered for reuse.

4.1.3 Non-LCA impacts – Indoor air quality

Already studies in the 1980s in the USA[65] showed that the contamination of indoor air by some of the most commonly encountered organic pollutants (VOCs) was between two and five times that found in outside air irrespective of whether it was in a rural or industrial environment. The importance of evaluating indoor air quality rises particularly in the recent years.

In the framework of the revision of the EU Ecolabel criteria revision there was a request from several stakeholders to change the testing procedure for VOCs and other compounds (including formaldehyde) from in-can measurements to Indoor Air Quality (IAQ) testing. IAQ tests the emissions of substances of interest from the paint during the drying process and when the paint is in use. This method has the advantage of eliminating concerns that suppliers to the paint manufacturers do not completely disclose the content of ingredients. It however, requires significant additional costs associated with independent testing.

New national legislation in some MS, in particular the regulations in France and Germany and the Regulation 305/2011/EU on construction products[66] push companies to provide IAQ testing results for certain products.

The French regulations require mandatory testing and labelling of paints for IAQ[67] through the scheme, called ANSES.[68] It requires testing to measure the emissions of paint in a sealed room 28

57 Crown Paints, Crown Paints Launches Carbon Revolution at Ecobuild, 2011. Available at: http://www.crowntrade.co.uk/LatestNews/LatestNewsStories/Pages/CrownPaintsLaunchesCarbonRevolutionatEcobuild.aspx
58 Paint +, Returned paint put to good use. Available at: http://www.paintplusuk.com/104/returned-paint-put-to-good-use/
59 Community RePaint. Available at: http://www.communityrepaint.org.uk/Where_Get_Paint.php
60http://www.calrecycle.ca.gov/condemo/paint/
61 http://www.thisisgloucestershire.co.uk/ways-recycling-paint-tins-users-urge/story-11893909-detail/story.html
62 http://www.recyclenow.com/what_can_i_do_today/can_it_be_recycled/liquids_and_chemicals/paint.html
63 http://www.hankinson.co.uk/news/hankinson-recycling-centre/
64http://www.leics.gov.uk/index/environment/waste/recycling_sites_and_permits/recycling_household_waste_sites/recycling_information.htm
65 EPA's Office of Research and Development's "Total Exposure Assessment Methodology (TEAM) Study" (Volumes I through IV, completed in 1985
66 Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, OJ L 88/5.
67 http://www.eco-institut.de/fileadmin/contents/International_Labelling/VOC/Arrete_etiquetage_2011.pdf.

days after application. The resultant classification system is similar to that implemented for energy efficiency of white goods (C to A+). Table 19 shows the concentrations of measured emissions from paints and the classification under the French regulations.

Table 19: Classification of IAQ based on emissions from paint under the French testing system (µgm^{-3})

Substances/Emissions class	A+	A	B	C
Formaldehyde	<10	<60	<120	>120
Acetaldehyde	<200	<300	<400	>400
Toluene	<300	<450	<600	>600
Tetrachloroethene	<250	<350	<500	>500
Xylene	<200	<300	<400	>400
1,2,4-Trimethylbenzene	<1000	<1500	<2000	>2000
1,4-Dichlorbenzene	<60	<90	<120	>120
Ethylbenzene	<750	<1000	<1500	>1500
2-Butoxyethanol	<1000	<1500	<2000	>2000
Styrene	<250	<350	<500	>500
Total VOC	**<1000**	**<1500**	**<2000**	**>2000**

The German AgBB[69] system, Health-related Evaluation of Emissions of Volatile Organic Compounds (VOC and SVOC) from Building Products, sets out restrictions on the level of emissions allowed for construction products (in particular flooring but can be applied to paints). An extensive list of chemicals is regulated, with limits described as “Lowest Concentrations of Interest” (LCI). Unlike the French system, these are maximum emission levels designed to remove the most polluting paints from the environment.

The development of the national schemes contributed to an EU-level harmonisation project by the Joint Research Centre (JRC), Institute for Health and Consumer Protection (IHCP) in Ispra. The project favours the LCI approach and aimed at delivering acceptable levels of emissions on 170 chemicals.[70] The ultimate goal is an EU-wide harmonised standard for IAQ that will apply to all building materials. The latest findings of this initiative were recently published in the report 'Harmonisation framework for health based evaluation of indoor emissions from construction products in the European Union using the EU-LCI concept'.[71]

A related but separate committee has been established under the European Committee for Standardisation (CEN) to develop a harmonised testing procedure for IAQ. This is in a response to the European Construction Products Directive (CPD) which requires manufacturers of construction products to declare “regulated properties” in CE marking. In addition to traditional properties such as

68 Agencenationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail.

69 Committee for Health-related Evaluation of Building Products (Ausschuss zur gesundheitlichen Bewertung von Bauprodukten).

70 Minutes of the 8th Indoor Air Quality (IAQ) Expert Group meeting 14 June 2011 – Luxembourg.

71 Kephalopoulos S., Geiss O., Annys E., Carrer P., Coutalides R., Crump D., Däumling C., De Brouwere K., De Lathauwer D., Dommaschk N., Gloeckner M., Harrison P., Heinzow B., Jaeckh R., Johanson G., Le Guern S., Rousselle C., Sateri J., Schuster A., Scutaru A.M., Tappler P., Uhl, M., Witterseh, T., Wolkoff, P., ECA report no. 29 on "Harmonisation framework for health-based evaluation of indoor emissions from construction products in the European Union using the EU-LCI concept", EUR 26168 EN. Luxembourg: Publications Office of the European Union, 2013. JRC83683.

Harmonisation framework for health based evaluation of indoor emissions from construction products in the European Union using the EU-LCI concept.

mechanical strength and fire safety, CPD refers also to the protection of hygiene, health and environment, which is interpreted to include air emissions[72].

Early 2014 it was decided that CPD will not cover paints and varnishes, thus they are no mandated tests for IAQ. Nevertheless, it is considered that "*they can be dealt with in a similar manner to construction products due to their emission properties*"[73] GPP is a voluntary scheme which aims to go beyond regulatory framework and favour better environmentally products. Therefore, including IAQ testing for GPP paints and varnishes seems reasonable in this context. Additionally, in the GPP criteria for buildings IAQ criterion is established for various subcomponents of a building. In order to seek for harmonisation this current proposal is kept.

In 2013 the standard EN 16402titled 'Paints and varnishes - Assessment of emissions of substances from coatings into indoor air - Sampling, conditioning and testing' was approved. It specifies *"a reference method for the determination of emissions from coatings into indoor air. This method is applicable to volatile organic compounds, semi-volatile organic compounds and volatile aldehydes. It describes the overall procedure and makes use of existing standards mainly by normative reference complemented when necessary with additional or modified normative requirements"*.[74]

4.2 Environmental evaluation and life cycle consideration for road markings

In accordance with EN 1436[75] **road markings** form a part of the means for horizontal signalization. They include longitudinal markings, arrows, transverse markings, text and symbols on the surface of the road and can be *'provided by the application of paint, thermoplastic materials or cold hardening materials, preformed lines and symbols or by other means'.* Road markings can be applied with or without the addition of glass beads. Majority of road markings are white or yellow.

Glass beads are tiny spherical glass balls used to achieve the retroreflection of the marking when the road marking is illuminated by vehicle headlamps. This retroreflection can also be improved, particularly for wet or rainy conditions, by special properties produced e.g. by the texture of the surface (in structured markings) or addition of large glass beads. Application of surface texture causes additionally that wheels of the passing vehicle can produce acoustic or vibration effects.

Glass beads are dropped on top of freshly applied road marking and/or can be mixed in with marking before it is applied. Glass beads can be treated to promote the good and correct embedment into the road marking product, with adhesion and flotation coating, or the combination of the two, to endow the road marking of retro reflection properties during life time.

There are various material technologies with different solidification methods used in road marking systems. According to information collected from industry among them there are:

- Water-borne paints – sprayed on the road surface, dry by coalescence and water evaporation, form a thin layer;
- Solvent-borne paints – sprayed on the road surface, dry physically by evaporation of solvent, form a thin layer;

72 Evaluation of a horizontal approach to assess the possible release of dangerous substances from construction products in support of requirements from the construction products directive, Energy Research Centre of the Netherlands, 2008.
73 See description of the standard available at: http://www.beuth.de/en/standard/din-en-16402/186065113.
74 European Committee for Standardisation website, Information regarding EN 16402:2013, available at:http://standards.cen.eu/dyn/www/f?p=204:110:0::::FSP_PROJECT:32045&cs=1C0890484F8DC05BB85B52607AC1F9CFB, accessed May 2014.
75 EN 1436:2007+A1, Road marking materials - Road marking performance for road users.

- Thermoplastics – applied in the molten state at about 200°C, either sprayed on (thin layer) or casted on as a melt (thick layer), solidifying by cooling;
- Reactive road marking systems (the so-called 2-component cold plastics) – mixed with a second hardener component. They are applied at ambient temperatures (are sprayed on (thin layer) or casted on (thick layer)) and solidify by chemical curing into an inert duroplastic polymer.

Some road markings form a film over the substrate (flat spray applied thin layer road markings or flat extruded thick layer road markings) and some do not. Examples of the later ones are agglomerated or structured road markings. They provide specific safety and performance features.

Conventional products like water- and solvent-based paints are in general considered to have a shorter life span than durable products, like thermoplastics, cold plastics or epoxy markings.

There are two types of markings - Type I and Type II. EN 1436 defines type II road markings as *'markings with special properties intended to enhance the retroreflection in wet or rainy conditions'*. Type I road markings do not necessarily have such special properties.

All in all, the choice of the road marking product should be adapted to the geographic location, climate, type of road, environmental conditions and the type of traffic in order to achieve the best environmental performance and least life-cycle cost.

Follow-up from the stakeholders' consultation

Stakeholders provided comments which highlighted the variety of systems used in different geographical locations. For instance in the UK most road markings in are hot melt thermoplastics. According to information provided in Greece approximately 90% of road marking used in this MS are solvent-based acrylics, as due to *"hot climate and high substrate temperatures hot melt and water-based road markings had given bad results (clack stripes from tyres)".*

Stakeholders pointed out also differentiating conditions of use and related to them need of application of different systems. For instance in densely populated countries as Germany traffic wear resistance of the road marking system is of higher importance than in the north of Finland of south of Italy, where the population density is significantly lower. Also in the drier southern countries nigh wet visibility may not be of the same relevance as in the regions with high precipitation.

It was pointed out that in e.g. in Germany, which has many highly frequented roads, public procurers prefer very durable systems with high retro-reflectivity at night and in wet conditions (the so-called Type II markings). The German regulations for road markings (ZTV M 13) require rather high retro-reflectivity (class R4 in dry and R3 in wet condition according to EN1436), which has implications for the minimum layer thickness. Type II markings, which are applied in thicker layers, both as flat (up to 2 mm) or textured road markings in form of agglomerates (from 2 kg/m^2) or profile markings (above 7mm). According to information from Germany, the later ones provide highest durability and enhanced safety performance (e. g. rumble effect) if compared with flat paint systems applied in thin layers.

4.2.1 Comparative life cycle assessments on selected road marking systems

Very few life cycle assessments have been conducted to determine the environmental performance of these systems. Hardly any non-industry led studies have been published, which was also highlighted by the stakeholders. Thus the results presented should be seen in this context.

The Austrian Institute for Industrial Ecology (Institut für Industrielle Ökologie) conducted a study aimed at comparing the various road marking systems from the environmental point of view. Information shared in form of presentation indicates that the analysis covered the aspects of traffic

safety, life-cycle costs, life span, health and environment. It included carbon footprint calculation for various systems, which results highlight the importance of long-lasting systems in contributing to environmental saving in greenhouse emissions. LCA was also conducted for the period of 10 years of using various road marking systems. The study indicated the cold plastics road marking systems as the most sustainable solutions for the Lower Austria roads. The technical report summarising the study, the assumptions made and its results is however not publicly accessible yet and will be further described in this report if available before the end of the project.

A summary of the few available studies and their main findings are given below.

4.2.1.1 A comparative cradle-to-grave LCA study for four types of road markings

Results of a recent comparative cradle-to-grave LCA study[76, 77, 78] of the four major binder-based material technologies has been provided to the project team by the stakeholders. It was a cross-industry LCA study, reviewed and certified by an independent expert panel according to ISO 14040 and ISO 14044.

The following environmental impact categories were analysed:

- Global warming potential (GWP100) [kg CO2-equiv.];
- Acidification potential (AP) [kg SO2-equiv.];
- Eutrophication potential (EP) [kg phosphate-equiv.];
- Photochemical ozone creation potential (POCP) [kg ethene-equiv.];
- Human toxicity potential (HTP) [kg DCB-equiv.];
- Terrestric ecotoxicity potential (TETP) [kg DCB-equiv.];
- Freshwater aquatic ecotoxicity potential (FAETP) [kg DCB-equiv.];
- Primary energy demand as an additional criterion.

The analysis was conducted on a marked one-kilometre road section equipped with a middle stripe and two edge lines with 280 m^2 marked area in total for an evaluation period of 10 years.

The results are presented, as provided by the stakeholders:

'Typical material formulations in characteristic application scenarios have been modelled using the data of corresponding official approval test certificates held by a major local manufacturer of all evaluated technologies. These certificates issued by the German Bundesanstalt für Straßenwesen (BASt – Federal Highway Research Institute) define, for instance, both the marking material and the broadcasted glass bead aggregate mixture along with the proper specific consumption per square meter that must be applied in practice on the road to comply with German performance standards.

These standards – DIN EN 1436 and ZTV M 02 – specify minimum thickness and performance figures, such as coefficient of retro-reflected luminance (RL) of the road marking, for example. Safety markings with high wet night-time visibility – so-called Type II markings – are characterised by a coefficient RL measured at a wet condition of at least 35mcd/m^2lx, for instance. The service life of such road markings is given by the time during which retroreflection remains above this threshold under traffic load.

In use-service life (lifetime) of the various systems on a typical German federal road bearing an average traffic of about 10000 to 15000 vehicles per day has been taken from empirical observations. It is noteworthy that these empirical figures are well in line with independent publications on relative lifetime of road marking systems.[79]

76 Evonik Industries AG, Life Cycle Assessment of Road Marking Substances and Systems, 2011.
77 Intertraffic Wourld, 'Life cycle under the lens', Annual Showcase, 2012.
78 Evonik, Vergleichende Ökobilanz-Studie für Straßenmarkierungssysteme", 77. Lacktagung, Bremerhaven, 2012.
79 Ökopol und IER Universität Stuttgart "European directive limiting the VOC content in certain products – Report on potential extensions of the directive covering road markings – Review of Directive 2004/42/EC, published 2011.

For all the systems, the environmental impact of the production, including the contributions of raw materials and energies up to the formulator's factory gate ("cradle to gate"), was first analysed per kilogram of produced road marking material. The analysis was then extended to the entire life cycle, through application and repainting, all the way to disposal ("cradle to grave") with impacts calculated per kilometre and per 10 years.

***"Cradle to gate" examination**: The environmental impact up to the factory gate is determined by the contributions of the formulation raw materials, while the formulation process as such and transportation, packaging, and wastes play a subordinate role. Among the formulation raw materials, energy-intensively produced substances such as the titanium dioxide pigment, glass beads in the case of CP and TP, solvents in the case of solvent-based paints, and the binder itself contribute the most to the ecological impact. The analysis shows that toxicological environmental impacts cannot be deduced exclusively from the statutory hazardous-substance classification of the formulation components. For example, the main contribution to the human toxicity potential per kilogram of cold plastic formulation arises not from the reactive resin binder, but from the titanium dioxide pigment in the formulation. The human toxicity potential per kilogram of water-based paint is not considerably lower since it contains similar amount of titanium dioxide.*[80]

***"Cradle to grave" examination:** The question of the environmental impacts arising per kilometre of marked road over an observation period of 10 years for the choice of a particular product alternative investigated safety markings with enhanced wet night-time visibility (type II), for instance. The study considered the following marking scenarios, which correspond in practice to the major applications: Thin layer (CSP, TSP, SB, WB), thick layer flat line (CP, TP) and thick layer agglomerates (CP, TP).*

***Thin layer:** All the four road marking systems respectively binder technologies can be considered for laying of thin-layer road markings. Transports, application and disposal do not contribute significantly, except for thermoplastic application where the material needs to be heated up to about 200°C to melt process it. However, Solvent-based or water-based systems have proven in practice to be much less durable than cold-spray plastics, so that significantly more material is consumed for the maintenance of a marking over a 10-year period. Spray applied thermoplastics are also durable, but in this case a long lifetime is achieved at the cost of high material consumption per application. It is evident from Figure 5 that for all systems the consumption of marking material and drop-on material dominates the life cycle assessment, while transport and application contribute much less to the global warming potential. This applies even to thermo spray plastic, which is processed at temperatures that may exceed 200°C. Similar trends have been found for Type I and Type II spray systems.*

In the same way, the long lifetime of cold-spray plastic compared with competitive systems has a positive impact also for all the other environmental effects investigated, as Figure 6 clearly shows.

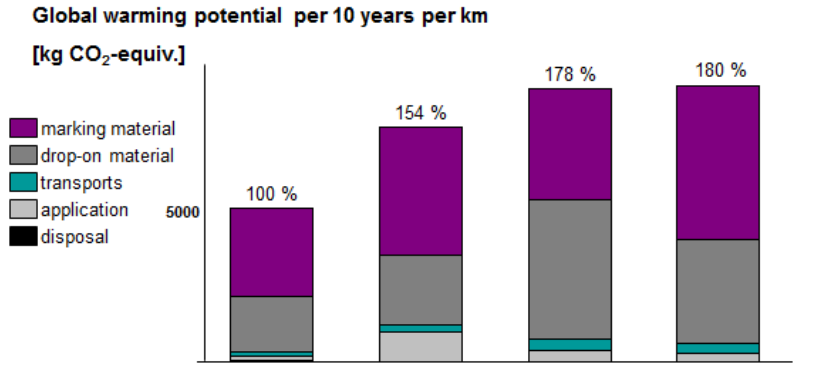
Cold-spray plastic is designated as a hazardous substance, and purely for this reason is generally considered to be less environmentally compatible than water-based or thermoplastic marking systems. This assumption is not upheld by the present study.

Even in regard to toxicological environmental impacts, no disadvantages have been found for marking with cold spray plastic as compared with thermo spray plastic or water-based paint.

The photochemical ozone creation potential (POCP) of a material determines ground level ozone formation, which is implicated in, for example, respiratory ailments in summer smog. The advantages of water-based over solvent-based paints in regard to POCP are often cited, and are evident also in the present study. The extension of the investigation to cold-spray plastic and thermo spray plastic shows, however, that these systems also offer attractive alternatives in regard to POCP. For thermoplastic application, possible contributions from, for example, products of

80 Human toxicity impact of TiO_2 originates from its production process, among others energy consumption for this process.

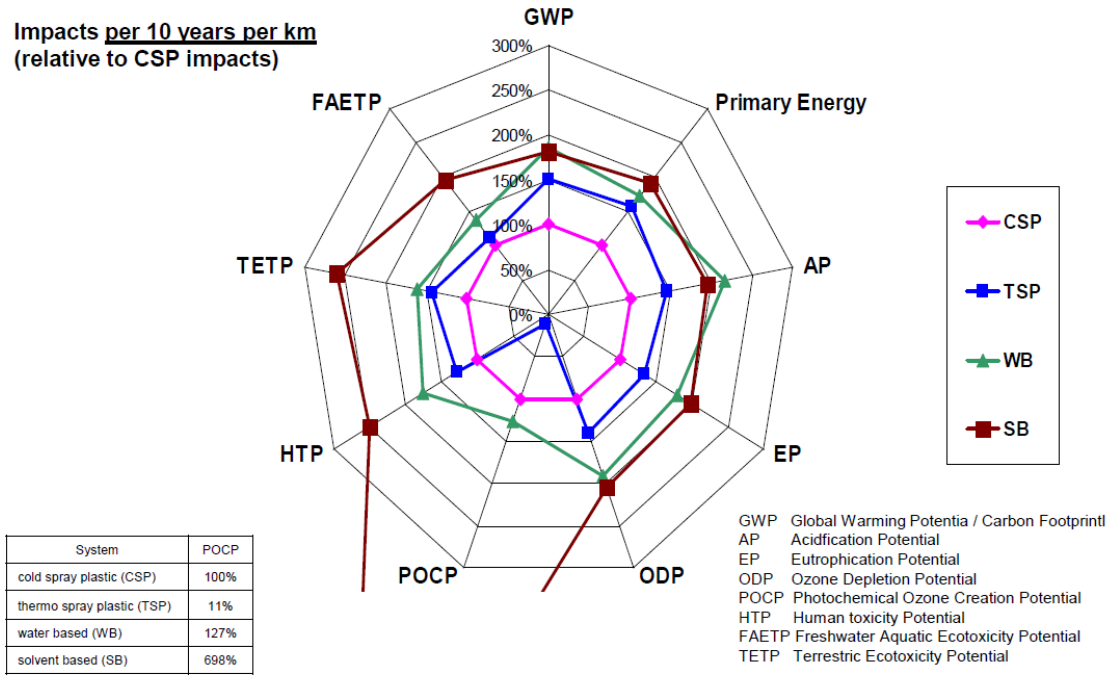
thermal decomposition or evaporation must also be investigated in the future; these have not been considered in the present study. The low POCP of, for example, cold-spray plastic, on the other hand, results from its long useful life.



	CSP	TSP	Water	Solvent
Thickness / mm	0.6	1.2	0.6	0.6
Lifetime / a	2.5	2.0	1.0	1.0

Figure 5: Global warming potential of various spray applied road markings per 10 years and road kilometre

Source: Evonik, 2011



System	POCP
cold spray plastic (CSP)	100%
thermo spray plastic (TSP)	11%
water based (WB)	127%
solvent based (SB)	698%

Figure 6: The ecological impacts of various road markings per 10 years and road kilometre relative to the corresponding impact of a road marking made of cold spray plastic (CSP)

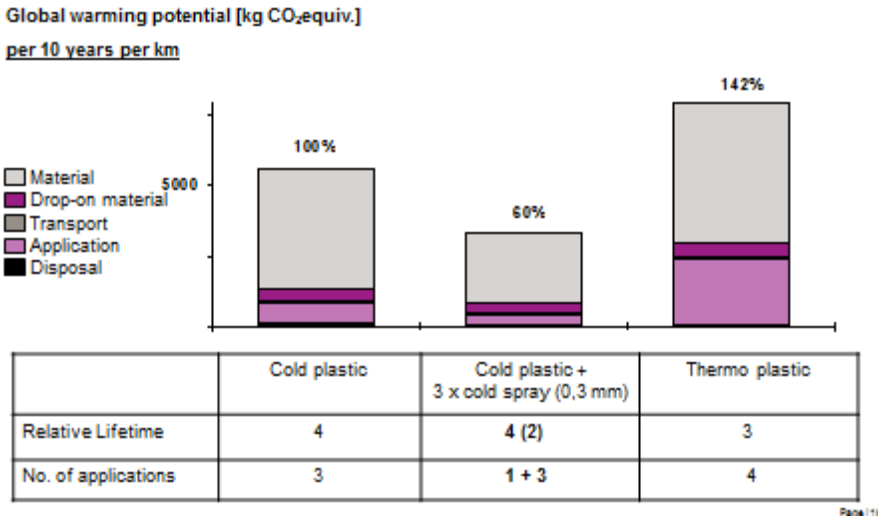
Source: Evonik, 2011

Thick-layer: *Thick-layer markings can be executed as flat lines as well as profiled or structured surfaces, or in the form of regular agglomerates of road markings. Type II road markings with enhanced night-time visibility at wet nights have been analysed.*

Flat-line markings*: The simplest case of a flat-line marking of, for example, 3 mm layer thickness can be executed with either cold plastic or thermoplastic, both having the same lifetime in practice. The two systems have a similar effect on the environmental impacts studied. Improvement of the environmental impacts by reduction of layer thickness- with no reduction in lifetime -has been reported and is technically possible for cold plastic flat-line markings.*

Structured road markings: *The study of a thick-layer agglomerate road marking shows how strongly the life cycle assessment of marking systems is determined by the application conditions and usage or wear characteristics. Figure 7 shows a comparison of the impacts on the global warming potential for the following cases:*

a) *Cold plastic (CP) agglomerates are applied and after the end of their useful life are removed and then renewed in the same way as thick layers.*
b) *Cold plastic (CP) agglomerate is refreshed several times after the end of its useful life with thin-layer cold-spray plastic (CSP), with a lifetime that is then shorter.*
c) *Thermoplastic (TP) agglomerates are applied, and after the end of their lifetime are removed and then renewed in the same way as thick layers. The great benefits of the refreshment technology are obvious. Due to the specific wear characteristic of the material refreshment of thermoplastic is not feasible.*



	Cold plastic	Cold plastic + 3 x cold spray (0,3 mm)	Thermo plastic
Relative Lifetime	4	4 (2)	3
No. of applications	3	1 + 3	4

Figure 7: Environmental impacts for structured road markings with cold plastic (CP) or initial application of cold plastic refreshed three times with 0.3 mm cold-spray plastic (CP+ 3 x CSP), or thermoplastic (TP)

Source: Evonik, 2011

Conclusions:

- *The use phase is dominating the overall environmental impacts.*
- *In-use service live, respectively durability of the road marking system is most crucial to reduce environmental impacts of road marking.*
- *Resource efficient technologies such as thin layer spray refreshment of structured thick layer road markings provide significant impacts savings.*

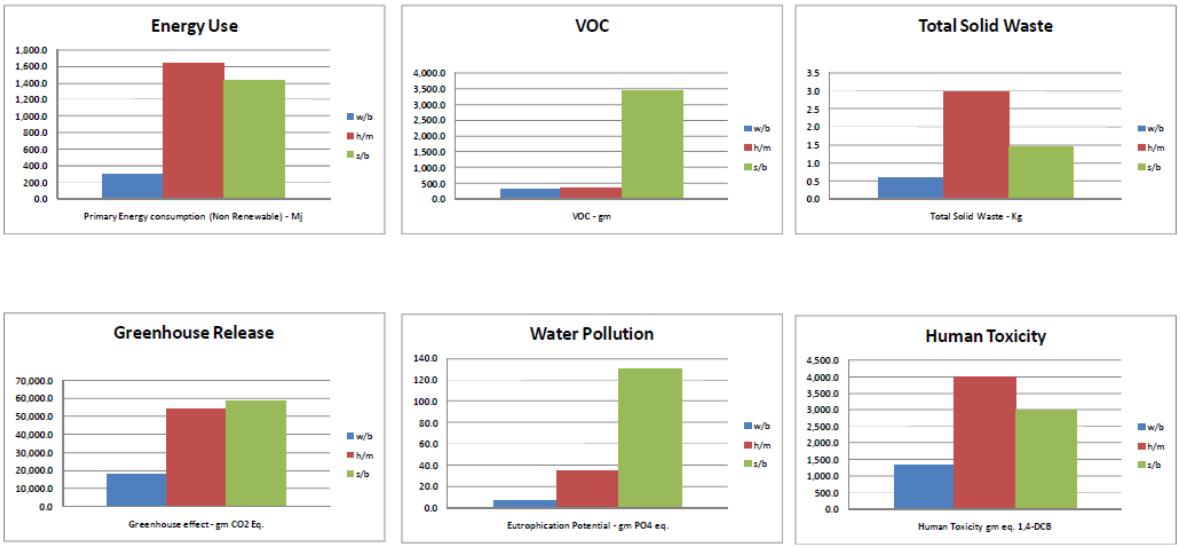
– *Solvents contribute most significant to POCP.*

There are various indirect environmental and social benefits from application of durable road marking systems that have not been accounted for in this study. More durable road markings require less frequent repainting and thus reduce the frequency of work zones on the roads. Road marking work is mainly repainting work done on single lanes while other lanes of the road are still under traffic. Work zone accidents are major threats to health and safety of the workers and the public travelling along. The use of more durable road marking systems contributes to accident reduction'.[81]

4.2.1.2 A comparative cradle-to-grave LCA study for solvent-based, water-based and hot melt paint

Dow[82] looked at solvent-based, water-based and hot melt paint (to cover 1 m^2 of highway with white colour reflective traffic markings for 10 years). Solvent-based paint carried large impacts in all six areas (energy use, VOC, total solid waste, GHG release, water pollution and toxicity to humans), with latex paint being the least harmful, especially regarding VOCs and water pollution.

Figure 8: A comparative life cycle assessment for road markings in the second study



Source: Simon Ward, Dow Coatings, 2011

This LCA commented on the following points:

Water-based paints (w/b above)

– Binders contribute the most significant impacts except water and VOC.

– TiO_2 contributes most water consumption and impacts on many other categories, reflecting its environmental impact.

81Provided by the stakeholder, contributing author in the study. [to be summarised, if more LCA studies on these 4 systems are found]

82 Simon Ward, Dow Coatings, 'Life Cycle Assessment (LCA) as a tool to evaluate the environmental impact of water-based, solvent-based and Hot Melt Road Marking Materials', 2011 New Zeeland Roadmarking Federation/RIAA Roadmarking Conference, Rotorua, New Zealand, 2001, available at: http://www.nzrf.co.nz/techdocs/conferencepapers2011/comparison_of_lifecycles.pdf, accessed May 2014.

- The production process contributes a relatively small impact compared to hot melt inputs.

Solvent-based paints (s/b above)

- Binders and VOC as per water-based.
- Solvents contribute most VOC, energy input and environmental and human toxicity.
- The production process contributes relatively small impact compared to hot melt inputs.

Hot Melt (h/m above)

- Similar to water-based paint, production for repaint contributes the most impact for all impact categories.
- The thickness of application is also a major factor relative to paint.
- The application stage contributes most to the greenhouse effect.[83]

Water-based paints had the lowest overall environmental impact in the above study.

A second study comparing water-based versus solvent-based road marking paints was conducted by Prosign Group[84]. The functional unit selected in the study was defined as follows: 'Covering of 1 m^2 of the road surface throughout its life cycle (10 years)'.[85] Nineteen environmental impact indicators were used, out of which for the comparative presentation of the results 6 indicators were selected:

- Greenhouse gas emissions (climate change);
- Volatile organic compound emissions;
- Eutrophication of the aquatic environment (asphyxia of aquatic fauna);
- Energy consumed;
- Potential toxicity;
- Waste generation.

Beside the baseline-reference scenario (i.e. application of only one initial layer, for each paint, 4 layers over a 10-year period for water-based paints and 5 layers – for solvent-based paints) two alternative scenarios were analysed for the application of an initial layer, followed by maintenance layers (1 initial layer and 9 maintenance layers):

- Alternative 1 (occurs frequently): The applier observes the recommended proportions for both paints.
- Alternative 2 (occurs occasionally): The applier uses the same quantity for both paints.

The results obtained in the study showed that for the reference scenario the environmental and health impacts analysed were at least 30% lower for water-based paints than those associated with the solvent-based road markings. For example, VOC emissions were 88% lower, especially during the application phase, for the water-based products, the results of eutrophication of the aquatic environment was by approximately 50% lower, energy consumed by nearly 60%.

[83] Note that this information is provided by a manufacturer promoting water-based paints.
[84] Prosign Group, The ecoprofile of Typhon, available online at: paint http://www.e-prosign.com/admin/images/upload_document/plaquette%20anglais_docd_73.pdf, accessed May 2014.
[85] To make the results easier to read, the functional unit was applied to the marking of 1 kilometre of roadway with two continuous 0.10-m edge lines and one discontinuous centre line (3 m of painted surface, 10 m of intervening space). This gives a total area of 223 m^2 of road markings with a life cycle of 10 years (life cycle of the road surface).

In the analysis of the first alternative scenario, water-based paint continues to perform better, from the environmental point of view, than the solvent-based paint. In case of the second alternative scenario either both paints obtained equivalent results or the water-based road marking performed better than the solvent-based one for majority of indicators.

4.2.1.3 Durability project – CEN TC 226/WG 2

Along the consultation process industry stakeholders indicated one more study which should be mentioned in the framework of the current project. The European Research Programme aimed at developing a single and unified method for testing the durability of road marking materials (as required by mandate M/111 "circulation fixtures') was conducted. A report from this study was provided to the project team by the stakeholders.

It was initiated in 2001 with the goal of identification and definition of the external factors which have a significant influence on the durability of road markings. Later the results and conclusions from this part of the project were used as basis for another phase, in which a road trials inter-comparison with the complementary participation of wear simulators was conducted.

Three questions have been set after agreeing on the project scope:

1. Do different trial sites give roughly equal relative marks to the materials?

2. Do different trial sites cause roughly equal relative marks to the different characteristics?

3. What factors determine the loads so that the loads at different trial sites can be predicted and compared?

These questions were, in general, answered negatively, as hardly any correlation could be found between results from different sites. The project did not allow developing a single method for testing the durability of road marking materials for the entire EU.

4.2.1.4 Summary of life cycle consideration for road markings

The main conclusions which can be drawn from the above-described studies can be summarised as follows:

- Use phase is dominating phase in the overall environmental impact of road markings.
- Extending the functional life time of the marking, i.e., its durability and related time before refreshments/need of repainting play a crucial to reduce environmental impacts of road markings.
- Solvent-based products contribute most significant to VOC emissions.
- Water-based products perform better if compared with solvent-based one in various impacts categories.
- Among the raw materials, energy-intensive ingredients such as the titanium dioxide pigment, glass beads (If recycled glass is used, the impact on the environment is lower), solvents, and the binder itself contribute the most to the environmental impact.

Based on the main points drawn from the analyses it is clear that the performance of road markings should play an important role in the GPP criteria in order to minimise environmental impacts related to them. Also the titanium dioxide pigment content, glass beads, solvents, and the binder itself shall be addressed. In later chapters (in the criteria rationale) also other features of relevance, not covered by the above analyses, are discussed (e.g., presence of certain metals in glass beads).

4.2.2 End of life and removal of road markings

Waste from removal of yellow thermoplastic and yellow painted traffic stripe- and pavement-marking contains lead chromate in concentrations between 350 and 1000 mg/kg. These residues may contain heavy metals that exceed established safety thresholds and may produce toxic fumes when heated.[86] There is evidence of a move away from these chemicals (for example it was pointed out by national association that newer yellow road marking systems, used in Germany as temporary road markings, does not contain heavy metal compounds like lead chromate) but they still ca be in use.

Some methods of line removal - such as the heated compressed air lance - produce fumes and smoke which, although not thought to be highly toxic, nonetheless carry a health/environmental hazard. Hydro-blasting is a newer technique whereby the waste elements are drawn by vacuum into a water tank, and then filtered for appropriate disposal.[87]

4.3 Summary of the key environmental considerations of paints and road markings

Based on the information gathered and analysed the following environmental impacts are associated with paint and road markings:

Table 20: Key environmental considerations linked to GPP for paints and road markings

Conclusion	Significance	Addressable in GPP
In-use durability	Very High	Yes, through performance criteria but indirectly
Unused paint and waste of paint	Very High	Yes, through mandating services to minimise wastage
Solvent-based paints have a higher environmental impact than water-based paints (and also other systems in the case of road markings)	High	Yes, by controlling the amount of VOC present in the paint
TiO_2 manufacture is an important environmental impact of paint production	Medium/High	Yes, reducing TiO_2 use can be achieved for paints but balancing with potential quality/performance loss is needed
Binder manufacture is an important environmental impact of paint production	Medium	No, technical information is currently not available to support requirements. Dictating the conditions for binder use may stifle innovation.
Additives have a wide range of health and environmental implications.	Medium	Yes, encouraging manufacturers to use alternatives whenever possible. Introducing restrictions on use of certain chemicals/chemicals function groups and regarding hazardous classification of the final product.
Paints emit volatile organic compounds which reduce indoor air quality (relevant for indoor paints only)	Medium	Yes, by ensuring high indoor air quality

86 Center for Environmental Excellence by the American Association of State Highway and Transportation Officials, 'The Compendium of Environmental Stewardship Practices in Construction and Maintenance', Chapter 5.5. Pavement Marking, available online at: http://environment.transportation.org/environmental_issues/construct_maint_prac/compendium/manual/5_5.aspx#tooltip, accessed May 2014.

87 Clean Break Ltd, England and Wales, 'Road Marking Removal efficiently, cleanly, environmentally friendly', available online at: www.markout.co.uk, accessed May 2014.

5 GREEN PUBLIC PROCUREMENT CRITERIA

The Communication on Green Public Procurement states that the GPP criteria shall be determined on a scientific basis considering the whole life cycle of products. In the frame of the project an analysis of available scientific evidence for paints and road markings and additional environmental evaluation using LCA of various stages of the product life for paints has been completed, as described in the technical background document available on the project's website[88] and summarised in section 4 (Technical analysis). Within data uncertainties and methodological limitations, the analysis allowed for identifying the main issues contributing to the environmental impacts.

Based on the analysis conducted the key issues to be considered for GPP criteria are proposed and presented in the following chapter. The GPP criteria proposal has been developed separately for:

1. Paints and varnishes;
2. Painting works contracts;
3. Road markings;
4. Road marking work contracts.

According to the Communication (2008) 400 Public procurement for a better environment[89], "*The core criteria are designed to allow easy application of GPP, focussing on the key area(s) of environmental performance of a product and aimed at keeping administrative costs for companies to a minimum. The "comprehensive" GPP criteria take into account more aspects or higher levels of environmental performance, for use by authorities that want to go further in supporting environmental and innovation goals. Since "core" criteria form the basis of the "comprehensive" criteria, this distinction between "core" and "comprehensive" will reflect differences in terms of ambition and availability of green products whilst at the same time pushing markets to evolve in the same direction*".

Different environmental areas are addressed in the GPP criteria proposal for paints, varnishes and road markings. They encompass mainly product formulation and content of specific compounds, emissions from the product, performance characteristics and issues related to end-of life phase. The criteria which are considered, from an LCA point of view, as addressing the key environmental impact parameters, are proposed as both – core and comprehensive. An overview of all the proposed GPP criteria is presented in Table 21.

In this chapter we present, for each criterion, proposed requirements, specific limit values and verification procedure. The rationale for the development of the parameters and values are based on the results of the life-cycle environmental assessments and reviewed studies, existing environmental schemes for this product group and information provided by stakeholders along the consultation process.

Besides core and comprehensive criteria, award criteria can be used for two purposes: in the first place when a purchaser is not sure that the market will be able to supply products or services that comply with all requirements, and in the second place when a purchaser wants to stimulate the suppliers to come forward with offers that promise a better performance. If used in that way, award criteria can be regarded as a method of stimulating innovation.

An overview of the proposed criteria is given in Table 21. The rationale substantiating the proposal and further explanations are given in below sections.

[88] The report is available at the project website: http://susproc.jrc.ec.europa.eu/paints/stakeholders.html.
[89] Available under: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0400:FIN:EN:PDF.

Table 21: Overview of Green Public Procurement criteria proposal for paints, varnishes and road markings

		Criterion	Core	Comprehensive
PAINTS AND VARNISHES				
TECHNICAL SPECIFICATIONS	1	Paint formulation		
	1.1	White pigment content	**X**	**X**
	1.2	Content of Volatile Organic Compounds	**X**	**X**
	1.3	Product hazard labelling	**X**	**X**
	1.4	Hazardous ingredients	**X**	**X**
	2	Efficiency of application and durability		
	2.1	Spreading rate	**X**	**X**
	2.2	Wet scrub resistance (indoor paints)		**X**
	2.3	Weathering resistance (outdoor paints)	**X**	**X**
	2.4	Fungal and algal resistance (outdoor paints)	**X**	**X**
	2.5	Abrasion resistance of floor paints (indoor and outdoor paints)	**X**	**X**
	2.6	Packaging	**X**	**X**
AWARD CRITERIA	1	Content of Semi Volatile Organic Compounds		**X**
	2	Indoor Air Quality: Indoor paints	**X**	**X**
CONTRACT PERFORMANCE CLAUSES	1	Technical advice and site inspections	**X**	**X**
PAINTING WORKS CONTRACTS				
SELECTION CRITERIA	1	Competencies of the tenderer	**X**	**X**
TECHNICAL SPECIFICATIONS	1	Use of paints meeting the EU GPP criteria	**X**	**X**
	2	Management of waste and unused paint	**X**	**X**
AWARD CRITERIA	1	Performance based painting contracts		**X**
	2	Reuse and/or recycling of waste and unused paint		**X**
CONTRACT PERFORMANCE CLAUSES	1	Management of paint handling	**X**	**X**
ROAD MARKINGS				
TECHNICAL SPECIFICATIONS	1	Road marking formulation		
	1.1	Content of Volatile Organic Compounds (VOC's)	**X**	**X**
	1.2	Product hazard labelling	**X**	**X**
	1.3	Hazardous ingredients	**X**	**X**
	2	Content of hazardous ingredients in glass beads	**X**	**X**
	3	Quality and durability of road marking system	**X**	**X**

AWARD CRITERIA	1	Road marking formulation – White pigment (titanium dioxide) content	**X**	**X**
	2	Glass beads – Recycled glass content		**X**
CONTRACT PERFORMANCE CLAUSES	1	Technical support and site inspections	**X**	**X**
ROAD MARKING WORKS CONTRACTS				
SELECTION CRITERIA	1	Competencies of the tenderer	**X**	**X**
TECHNICAL SPECIFICATIONS	1	Use of road markings meeting the EU GPP criteria	**X**	**X**
	2	Management of waste and unused road marking material	**X**	**X**
AWARD CRITERIA	1	Performance based contracts		**X**
CONTRACT PERFORMANCE CLAUSES	1	Management of road marking usage and application	**X**	**X**

Follow-up from the stakeholders' consultation

- **Paints**

In general the comments received from the stakeholders along the consultation process referred to details of the proposed criteria, mainly alignment with the EU Ecolabel and strictness of the proposed values. One bigger change in the new set is the removal of the requirements on energy consumption from titanium dioxide production due to lack of consensus over the proposal, which is a new approach when compared with the EU Ecolabel. It is however proposed to take up this subject in the future revisions of the EU Ecolabel and GPP criteria. For more detail see section 5.1.2.3.

Single issues raised by the stakeholders and amendments made are addressed in the sections presenting the rationale of each criterion.

- **Road markings**

A brief summary of the main comments follows, whilst specific comments on criteria formulation are addressed per criterion in the respective section of this report (rationale of each single criterion).

Generally, the comments received from some stakeholders regarding road markings criteria indicated that the latter did not take into account special characteristics of solvent-borne coatings and road marking systems applied in thicker layers. Additionally, some stakeholders highlighted the importance of addressing properly aspects of the product life cycle performance as well as potential trade-offs between environmental and product performance/driver's safety benefits.

It was highlighted that in the last draft proposal there was a focus on TiO_2 and solvents. These are however the main environmental hotspots for this product group and need to be addressed through GPP.

It was pointed out that the comprehensive criteria proposal would risk to favour only thin Type I water-borne systems that may has low durability. The necessity to take a system approach and focus on the durability of the road marking system was suggested.

Moreover, the stakeholders emphasized that the road markings are systems composed of pigmented material and drop-on material that are required to provide the functionality of the product leading in improving road safety. Therefore, the criteria should more clearly indicate which elements of the road marking system are addressed through which criteria. And in general, the GPP shall address the road marking system as a whole.

Finally, it was added that the environmental impact of the application process should be considered as this could be higher than the environmental impact of the product itself, for instance impacts from SVOC from melt processing of thermoplastics at 200°C. However, there was no supplementary evidence and information provided on this point and there is lack of published information available to establish a requirement on this point. The LCA quoted in the report (see section 4.2.1) shown that the consumption of marking material and drop-on material dominates the life cycle assessment, while transport and application contribute much less to the global warming potential, which also applies thermos-spray plastic, which is processed at temperatures above 200°C.

Conducting an LCA for the entire system could be an option to better evaluate the entire road marking systems, it is however considered premature at present. Many tenderers, especially SMEs could lack expertise and common rules would need to be established. This possibility should however be considered in the future, shall this expertise and a common set of product category rules be available.

5.1 PAINTS AND VARNISHES

In the following sections core and comprehensive criteria for the *purchase of paints with a reduced environmental impact* are presented. First, technical specifications are addressed, followed by award criteria and contract performance clauses. For each proposal a brief explanation on the substantiating rationale or additional information regarding specific aspects are provided.

5.1.1 TECHNICAL SPECIFICATIONS FOR PAINTS AND VARNISHES

5.1.1.1 Criterion 1 Paint formulation

5.1.1.1.1 Criterion 1.1 White pigment content

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
1.1 White pigment content *(This requirement does not apply to transparent and semi-transparent coatings)* Paints shall have a white pigment content (white inorganic pigments with a refractive index higher than 1,8) per m^2 of dry film equal to or lower than: • 38 g/m^2 for indoor paints, with the exception of indoor wall paints claiming Class 1 wet scrub resistance (WSR) for which 40 g/m^2 shall apply; • 40 g/m^2 for all outdoor paints. Undercoats and primers shall have a white pigment content (white inorganic pigments with a refractive index higher than 1,8) per m^2 of dry film equal to or lower than 25 g/m^2. **Verification:** The tenderer shall provide documentation for the paint formulation showing the content of white pigments. Where required, Class 1 wet scrub resistance shall be demonstrated based on a test report carried out according to EN 13300 using the method EN ISO 11998 (Test for cleanability and scrub resistance). Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.	**1.1 White pigment content** *(This requirement does not apply to transparent and semi-transparent coatings)* Paints shall have a white pigment content (white inorganic pigments with a refractive index higher than 1,8) per m^2 of dry film equal to or lower than: • 36 g/m^2 for indoor products, with the exception of indoor wall paints claiming Class 1 wet scrub resistance (WSR) for which 40 g/m^2 shall apply; • 38 g/m^2 for outdoor paints. Undercoats and primers shall have a white pigment content (white inorganic pigments with a refractive index higher than 1,8) per m^2 of dry film equal to or lower than 25 g/m^2. **Verification:** The tenderer shall provide documentation for the paint formulation showing the content of white pigments. Where required, Class 1 wet scrub resistance shall be demonstrated based on a test report carried out according to EN 13300 using the method EN ISO 11998 (Test for cleanability and scrub resistance). Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.

Rationale

Hiding power of the paint can be defined as the ability of paint to hide a surface, colour or stain over which it is applied. It is a property which enables it to obliterate beyond recognition any background over which it may be spread".[90] Hiding power is provided by the paint's pigment. As shown in the LCA review section, reduction in the use of pigment in paints, particularly titanium dioxide, is desirable because it is a major contributor to the paint's environmental impact.

Pigment has an effect on the opacity of paint; therefore any reduction in use must be balanced against a reduction in the performance. Paint spreading performance is linked to the amount of pigment added to the paint. In the framework of the EU Ecolabel revision anonymised data were collected for EU Ecolabel paints from the competent bodies responsible for the verification of the compliance of products with Ecolabel criteria (see Table 22).

Table 22: Amount of TiO_2 per m^2 of EU Ecolabel paints

Type	Number of paints	Average white pigment (g/m^2)	Standard deviation (g/m^2)	Current EU Ecolabel threshold (g/m^2)
Indoor	58	23.5	8.6	36
Outdoor	12	18.1	13.3	38

Analysis of the cumulative frequency shows that amounts of titanium dioxide vary in submitted paints, with only a small proportion of paints having greater than $30g/m^2$ of white pigment (see Figure 9). It was nevertheless commented by the stakeholders that that these figures are low and that the amount of TiO_2 in paint in Southern Europe is considerably higher.

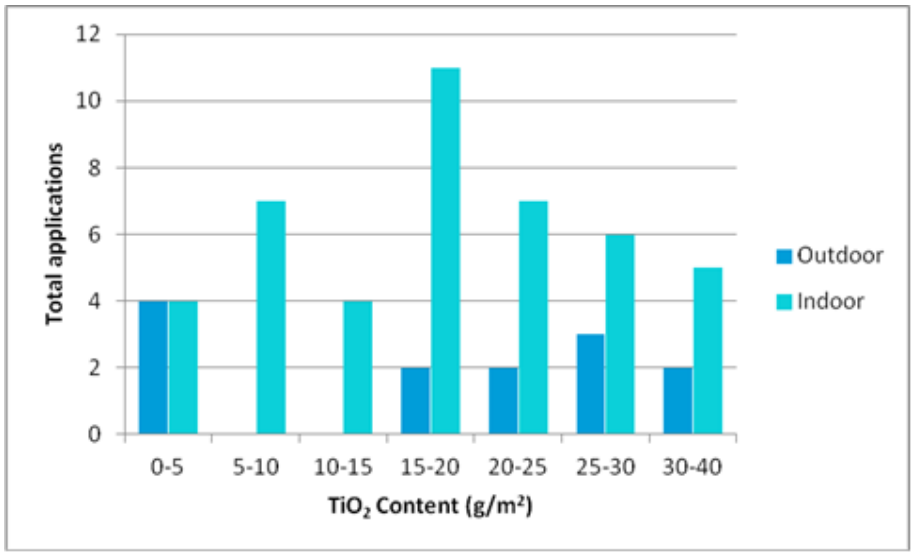


Figure 9: TiO_2 content in EU Ecolabel paints

Based on the further consultation with stakeholders new threshold values for the EU Ecolabel paints have been set. It is proposed that the limit values for the **comprehensive** Green Public

90 Henry A. Gardner, George G. Sward, ASTM International, 1972.

Procurement **criteria** shall be aligned with the recently adopted (June 2014) EU Ecolabel thresholds for TiO_2 content, i.e.

> **Comprehensive criterion**: Paints shall have a white pigment content (white inorganic pigments with a refractive index higher than 1,8) per m^2 of dry film equal to or lower than 36 g/m^2 for indoor products and 38 g/m^2 for outdoor products, with the exception of indoor wall and ceiling paints claiming Class 1 WSR[91] for which 40 g/m^2 shall apply.
> Undercoats and primers shall have a white pigment content (white inorganic pigments with a refractive index higher than 1,8) per m^2 of dry film equal to or lower than 25g/m^2.

Regarding the **core criterion** slightly less stringent value of 38 and 40 g/m^2, which were also discussed along the criteria development process for indoor and outdoor paints, respectively, are proposed. For undercoats and primers the value consistent with the EU Ecolabel criteria is proposed as this was agreed for this kind of products along the consultation process. Due to the fact that stakeholders' feedback on the applicable values for this criterion was very limited, further input was sought.

The criterion proposal is formulated as follows:

Core criterion: Paints shall have a white pigment content (white inorganic pigments with a refractive index higher than 1,8) per m^2 of dry film equal to or lower than 38 g/m^2 for indoor paints, with the exception of indoor wall and ceiling paints claiming Class 1 WSR[91] for which 40 g/m^2 shall apply, and 40 g/m^2 for all outdoor paints. Undercoats and primers shall have a white pigment content (white inorganic pigments with a refractive index higher than 1,8) per m^2 of dry film equal to or lower than 25 g/m^2.

Regarding **verification** of compliance of the tendered product the tenderer shall provide documentation for the paint formulation, supported by testing results, showing that the content of white pigments is compliant with this criterion. An additional requirement for testing is appropriate in order to strengthen the compliance for procurers.

Follow-up from the stakeholders' consultation

In general there were not many comments regarding the proposed values. Only one stakeholder asked for stricter limit for undercoats, while another found the proposed values too high. However, no supplementary technical information was provided. Also in the final consultation round Belgian painting sector mentioned that the limits for undercoats are too strict, taking into account the spreading rate. It should however be mentioned that the current values are based on the discussion conducted in the framework of the EUEcolabel criteria revision and it is considered that there are many products available on the market which fulfill at present the proposed GPP criteria.

5.1.1.1.2 Criterion 1.2 Content of Volatile Organic Compounds (VOC's)

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
1.2 Content of Volatile Organic Compounds The maximum content of Volatile Organic Compounds (VOCs) shall not exceed the limits given in Table 23. The content of VOCs shall be determined for the	**1.2 Content of Volatile Organic Compounds** The maximum content of Volatile Organic Compounds (VOCs) shall not exceed the limits given in Table 24. The content of VOCs shall be determined for the

91 WSR = wet scrub resistance.

ready to use product and shall include any recommended additions prior to application such as colourants and/or thinners.

Table 23 VOC content limits

Product description (with subcategory denotation according to Directive 2004/CE/42)	**VOC limits (g/l including water)**
a. Interior matt walls and ceilings (Gloss <25@60°)	15
b. Interior glossy walls and ceilings (Gloss >25@60°)	60
c. Exterior walls of mineral substrate	30
d. Interior/Exterior trim and cladding paints for wood and metal	90
e. Interior trim varnishes and woodstains, including opaque woodstains	75
e. Exterior trim varnishes and woodstains, including opaque woodstains	90
f. Interior and Exterior minimal build woodstains	75
g. Primers	15
h. Binding primers	15
i. One-pack performance coatings	100
j. Two-pack reactive performance coatings for specific end use such as floors	100
Decorative effect coatings	90
Anti-rust paints	80

Verification:
The tenderer shall provide either:

a) a calculation of the VOC content, supported, if available, by Safety Data Sheets or;

b) a test report carried out according to ISO 11890-2. Products with a VOC content lower than 1.0 g/l shall be tested according to ISO 17895.

Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.

ready to use product and shall include any recommended additions prior to application such as colourants and/or thinners.

Table 24 VOC content limits

Product description (with subcategory denotation according to Directive 2004/CE/42)	**VOC limits (g/l including water)**
a. Interior matt walls and ceilings (Gloss <25@60°)	10
b. Interior glossy walls and ceilings (Gloss >25@60°)	40
c. Exterior walls of mineral substrate	25
d. Interior/Exterior trim and cladding paints for wood and metal	80
e. Interior trim varnishes and woodstains, including opaque woodstains	65
e. Exterior trim varnishes and woodstains, including opaque woodstains	75
f. Interior and Exterior minimal build woodstains	50
g. Primers	15
h. Binding primers	15
i. One-pack performance coatings	80
j. Two-pack reactive performance coatings for specific end use such as floors	80
Decorative effect coatings	80
Anti-rust paints	80

Verification:
The tenderer shall provide either:

a) a calculation of the VOC content, supported, if available, by Safety Data Sheets or;

b) a test report carried out according to ISO 11890-2. Products with a VOC content lower than 1.0 g/l shall be tested according to ISO 17895.

Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.

Rationale

Volatile Organic Compounds (VOCs) are used as solvents within paints to help keeping the mixture stable prior use and aiding in spreading and delivery of the paint to the substrate. As described in

section 4.1.2.2.3, they encompass a wide variety of compounds, which generally evaporate or sublimate from the paint during and after application. VOCs have been identified as substances with negative effect with regards to global warming, ozone layer depletion, fauna and flora degradation.

Moreover, many VOCs have short- and long-term adverse health (e.g. respiratory) and other environmental effects.[92] VOCs emissions can cause among others eye, nose, and throat irritation, headaches and loss of coordination. More severe reactions to VOCs exposure enclose damage to liver, kidney and central nervous system. Some are suspected to be carcinogenic.

As shown in the technical analysis section, solvent based paints have a higher environmental impact than water based paints. This is mainly due to the use of solvents. Content of VOCs was identified as an environmental hot spot in the LCA studies. Therefore, in order to ensure that more environmentally friendly paints are purchased by the public authorities it is proposed to require that tenderers offer only paints with reduced amount of VOCs in the formulation. It should be noted that, since public awareness on this aspect is high, paint industry has been working for years towards the reduction of VOCs in their products.

Data on VOC content of the EU Ecolabel paints and varnishes was collected and analysed as part of the revision of the EU Ecolabel (It should be highlighted that the EU Ecolabel for paints is a successful product group with over 1150 products awarded in 2010). The results are presented in Table 25. This was used as the starting point for proposals and can be used as an indication of the performance of the best performing products on the market.

Table 25: Data on VOCs content of EU Ecolabel paints and varnishes

	Competent body data		
Type	Average (g/l including water)	Standard deviation (g/l including water)	No. of EU Ecolabel licences
Pack performance coatings	77.8	21.6	8
Exterior trim and cladding paints for wood and metal including undercoats	41.2	2.7	10
Exterior trim varnishes and wood-stains, including opaque woodstains	12.0	7.9	23
Interior Matt (walls/ceiling) (Gloss < 25@60 °)	2.9	3.4	60
Interior minimum build woodstains	42.5	14.8	6
Interior trim and cladding paints for wood and metal including undercoats	70.9	18.3	16
Interior trim varnishes and wood-stains, including opaque woodstains	46.9	23.8	35
Primers (indoor)	5.0	0.0	2

The Paints Directive 2004/42/EC sets mandatory VOC limits for various types of paints. In the current study data gathered from dossiers of successful EU Ecolabel applications have been

92 For more details see a section of 'An Introduction to Indoor Air Quality (IAQ) - Volatile Organic Compounds (VOCs)', available online at the US Environmental Protection Agency website: http://www.epa.gov/iaq/voc.html.

provided as anonymised data from the Competent Bodies and analysed. The outcomes of this analysis and further stakeholders consultation substantiated the proposed limits, which go beyond the values set by the directive (see Table 25). VOC content shall be measured at the point of application and must include any additional solvent added to the paint prior to application.

Thus, in the GPP criteria the rather more strict values, which are aligned with recently adopted new EU Ecolabel criteria limit values for VOCs[93], are proposed only for the **comprehensive criteria** set; while rather less strict thresholds, which were applied in the previous EU Ecolabel criteria [94] (with the exception of the value for 'Exterior walls of mineral substrate' where a lower threshold of 30 g/l is proposed) are now proposed for the **core criteria** (see Table 26 below). These limit values were obligatory for EU Ecolabel licence holders since 2008. They are lower than the ones indicated in the directive.

Table 26: Comparison of VOC content limits in 2004/42/EC Directive and 2008 and 2014 EU Ecolabel criteria

Product description (with subcategory denotation according to Directive 2004/CE/42)	**VOC limits from 2004/42/EC Directive** *(g/l including water)*	**VOCs limits in 2008 EU Ecolabel Decision** (g/l including water)	**VOCs limits in 2014 EU Ecolabel Decision** (g/l including water)
a. Interior matt walls and ceilings (Gloss <25@60°)	30	15	10
b. Interior glossy walls and ceilings (Gloss >25@60°)	100	60	40
c. Exterior walls of mineral substrate	40	30	25
d. Interior/Exterior trim and cladding paints for wood and metal	130	90	80
e. Interior trim varnishes and woodstains, including opaque woodstains	130	75	65
e. Exterior trim varnishes and woodstains, including opaque woodstains	130	90	75
f. Interior and Exterior minimal build woodstains	130	75	50
g. Primers	30	15	15
h. Binding primers	30	15	15
i. One-pack performance coatings	140	100	80
j. Two-pack reactive performance coatings for specific end use such as floors	140	100	80
l. Decorative effect coatings	200	90	80
Anti-rust paints	-	80	80

93Commission Decision of 28 May 2014 establishing the ecological criteria for the award of the EU Ecolabel for indoor and outdoor paints and varnishes (2014/312/EU).

94Commission Decision of 13 August 2008 establishing the ecological criteria for the award of the Community eco-label to indoor paints and varnishes (2009/544/EC).

Regarding **verification** it was initially considered that calculations would be difficult to verify by a procurer without additional technical input. Thus, test results were proposed as verification proof to provide greater assurance without any need for technical expertise. The VOC content shall be determined using the methods given in ISO 11890-2[95] or, alternatively for products with a VOC content of less than 1.0g/l, the methods given in ISO 17895[96] or equivalent. The two testing methods mentioned are specified in the Directive 2004/42/EC. Nevertheless, after the consultation with stakeholders it was agreed to align the verification with EU Ecolabel and to allow also proving compliance using the calculation made by the producer.

Follow up from stakeholders' consultation

Limited but contradicting feedback was received from the stakeholders regarding the proposed thresholds. Some agreed with the proposal; few considered it as too strict or too loose. No additional technical evidence was however provided to substantiate changing the proposed values. As explained above, the proposal is based on the developments in the EU Ecolabel schemes and it is considered feasible along the EU Ecolabel consultation.

The content of VOC is one of the key environmental aspects for paints thus it is considered appropriate to keep the values low. In general it is considered that the level of strictness of the comprehensive criteria should correspond to the level of strictness of the EU Ecolabel criteria, as it is done in the current proposal. The comprehensive ones are aligned with the old EU Ecolabel criteria, with which a numerous of paint products could comply (the paints and varnishes product group is one of the most successful in the EU Ecolabel scheme).

Finally, one stakeholder asked for exemption for using solvent-based products in old buildings which are renovated and in historical buildings where the intension is to restore the surface as close as possible to the original one. For instance it was explained that in old buildings trim parts are often painted with high gloss materials (typical >80 GU at 20◦), which cannot be achieved by waterborne alternatives. The following technical rational was provided: "*the film-forming process of solvent borne alkyds versus waterborne technologies differs. The development of the surface tension of the wet paint during drying has an impact on the final end result with respect to gloss. For solvent borne paints this development differs from waterborne paints. Consequently leading to a different result. Especially when doing restorations, the end result should be as close as possible to the original. Therefore it is of importance to be able to use materials which are based on similar technology as the original".* Such a situation could be solved through an additional guidance to the criteria document, which would specify that criteria should not apply in some specific situations like the case of restoration of historical buildings as mentioned above. The following addition is made in the introductory section of the GPP criteria:

> *"In case it is required to preserve the original character of painted surface e.g. restoration of the interior or exterior of an old building being restored, paint that will not fulfil the requirements of the GPP criteria may be needed. In this case the procurer, supported by technical advisors, shall evaluate the respective need and the availability of alternative solutions, and if necessary, contracts for paints to be used on these surfaces may be exempted from the GPP requirements. Market enquiries could be used to determine if alternatives with suitable performance requirements may be available".*

95 ISO 11890-2 Paints and varnishes – Determination of volatile organic compound (VOC) content -- Part 2: Gas-chromatographic method.

96 ISO 17895 Paints and varnishes – Determination of the volatile organic compound content of low-VOC emulsion paints (in-can VOC).

5.1.1.1.3 Criterion 1.3 Product hazard labelling

<table>
<tr><th>Core criteria</th><th>Comprehensive criteria</th></tr>
<tr><td colspan="2">TECHNICAL SPECIFICATIONS</td></tr>
<tr><td>

1.3 Product hazard labelling

The final product shall not be classified as being acutely toxic, a specific target organ toxicant, carcinogenic, mutagenic or toxic for reproduction, hazardous to the environment, in accordance with Regulation (EC) No 1272/2008 (CLP Regulation), as indicated in Table 27.

Table 27: Final product classification

<table>
<tr><td>Acute toxicity</td><td>Acute Tox. 1
Acute Tox. 2
Acute Tox. 3</td></tr>
<tr><td>Specific target organ toxicity – repeated exposure
Specific target organ toxicity – single exposure</td><td>STOT RE 1 or 2
STOT SE 1, 2 or 3</td></tr>
<tr><td>Carcinogenicity</td><td>Carc. 1A
Carc. 1B
Carc. 2</td></tr>
<tr><td>Germ cell mutagenicity</td><td>Muta. 1A
Muta. 1B
Muta. 2</td></tr>
<tr><td>Reproductive toxicity</td><td>Repr. 1A
Repr. 1B
Repr. 2</td></tr>
<tr><td rowspan="2">Hazardous to the aquatic environment</td><td>Aquatic Acute 1</td></tr>
<tr><td>Aquatic Chronic 1 or 2</td></tr>
</table>

Verification:

The tenderer shall provide appropriate documentation confirming that the products to be supplied are not classified with the listed hazards.

The documentation of the mixture classification shall be provided in accordance with the rules provided in Regulation (EC) No 1272/2008 (CLP Regulation) and/or Safety Data Sheets.

Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.

</td><td>

1.3 Product hazard labelling

The final product shall not be classified as being acutely toxic, a specific target organ toxicant, a respiratory or skin sensitizer, or carcinogenic, mutagenic or toxic for reproduction, hazardous to the environment, in accordance with Regulation (EC) No 1272/2008 (CLP Regulation), as indicated in Table 28.

Table 28: Final product classification

<table>
<tr><td>Acute toxicity</td><td>Acute Tox. 1
Acute Tox. 2
Acute Tox. 3</td></tr>
<tr><td>Specific target organ toxicity – repeated exposure
Specific target organ toxicity – single exposure</td><td>STOT RE 1 or 2
STOT SE 1, 2 or 3</td></tr>
<tr><td>Carcinogenicity</td><td>Carc. 1A
Carc. 1B
Carc. 2</td></tr>
<tr><td>Germ cell mutagenicity</td><td>Muta. 1A
Muta. 1B
Muta. 2</td></tr>
<tr><td>Reproductive toxicity</td><td>Repr. 1A
Repr. 1B
Repr. 2</td></tr>
<tr><td rowspan="3">Hazardous to the aquatic environment</td><td>Aquatic Acute 1</td></tr>
<tr><td>Aquatic Chronic 1 or 2</td></tr>
<tr><td>Aquatic Chronic 3*</td></tr>
<tr><td>Respiratory sensitization</td><td>Resp. Sens. 1, 1A or 1B</td></tr>
<tr><td>Skin sensitization</td><td>Skin Sens. 1 , 1A or 1B</td></tr>
</table>

* The final product shall be allowed to be classified with H412 only in the case of the use of dry film preservative combinations containing 3-iodo-2-propynyl butylcarbamate (IPBC) in outdoor paints and varnishes at concentrations equal to or lower than 0.650% w/w.

Verification:

The tenderer shall provide appropriate documentation confirming that the products to be supplied are not classified with the listed

</td></tr>
</table>

	hazards. The documentation of the mixture classification shall be provided in accordance with the rules provided in Regulation (EC) No 1272/2008 (CLP Regulation) and/or Safety Data Sheets. Where relevant, for outdoor products classified with aquatic chronic toxicity 3 and containing IPBC tenderers shall provide documentation specifying that the content of IPBC combination is equal to or lower than 0.650% w/w. Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.

Rationale

Paints are products formulated as a mixture consisting of very high number of various compounds; i.e. binders, solvents, pigments and additives. Among additives there are e.g. driers, biocides, fungicides plasticisers, emulsifiers, UV stabilizers, anti-skinning agents or corrosion inhibitors. As mentioned in section 4.1.2.1, an online paint product directory[97] contains in 10,000 different resin/polymer formulations, 9,000 additives and 4,500 pigments and fillers. This results in a very wide range of different paint formulations. It is therefore not straightforward to control the content of paint products.

The Dangerous Substances Directive (DSD)[98] is an EU legislation concerning chemical safety introduced in 1967. It is applied to chemicals and mixtures of chemicals. DSD lists the classes of substances or preparations that are considered to be dangerous. Some of these classes were linked with a hazard symbol and/or a code. The new Classification, Labelling and Packaging (CLP) Regulation[99] replaces the current system of classification of substances and mixtures. A transition period where both these legal acts are in force applies until 31 May 2015. This means that products can be still found on the market that display the old labels.

This proposed criterion excluding certain product hazard classification and labelling is considered as a safety net to ensure that the public authorities do not purchase products which are classified as hazardous to human health or the environment[100]; i.e. which are:

- Acutely toxic;
- A specific target organ toxicant;
- Carcinogenic, mutagenic or toxic for reproduction;
- Hazardous to the environment (H400, H410, H411);
- Respiratory or skin sensitizers (only in comprehensive criteria set).

Very similar requirements were set also in the old EU Ecolabel for paints and varnishes (see Criterion 5 – Restriction of hazardous substances and mixtures in the Decision 2014/312/EU*)*.

Table 29 presents respective final product classifications in both CLP Regulation and DSD Directive.

97Available at SpecialChem website: http://www.specialchem4coatings.com/.

98Council Directive 67/548/EEC of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances.

99 Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.

100 In accordance with Regulation (EC) No 1272/2008 of the European Parliament and of the Council (the 'CLP Regulation') or Council Directive 67/548/EC (the 'DSD Directive').

Table 29: Final product classification equivalence in CLP and DSD Directives addressed in GPP core criteria

CLP Mixture classification	DSD equivalent
Acutely toxic	T or T+
Specific Target Organ Toxicant	T, T+ or Xn
A Carcinogen, Mutagen or Reproductive toxicant	Carcinogen, Mutagen or Reproductive toxicant categories 1-3
H400, H410, H411	N

It is considered that it can be useful for procurers to easily identify the labels, so it is also proposed to include the label within the appendix of the criteria for easy reference. Given the transition period between the two systems, it was initially proposed to highlight in the criteria the equivalence between labels under CLP and DSD (see Annex I of the criteria text). However, as the criteria will not be valid before June 2015 the reference to the DSD can be removed.

In addition to the labelling that may need to be displayed on the product, for certain categories of hazards the manufacturer may also be required to display on the product certain precautionary statements. For example in the case of the four categories of hazards to the aquatic environment P273 precautionary statement mentioned in Figure 10, would read *'Avoid release to the environment*'.

ACUTE AQUATIC HAZARD	
	Acute 1
GHS pictogram	
Signal word	Warning
Hazard statement	H400: Very toxic to aquatic life
Precautionary statement prevention	P273
Precautionary statement response	P391
Precautionary statement storage	
Precautionary statement disposal	P501

LONG-TERM AQUATIC HAZARD				
	Chronic 1	Chronic 2	Chronic 3	Chronic 4
GHS pictograms			No pictogram is used	No pictogram is used
Signal word	Warning	No signal word is used	No signal word is used	No signal word is used
Hazard statement	H410: Very toxic to aquatic life with long lasting effects	H411: Toxic to aquatic life with long lasting effects	H412: Harmful to aquatic life with long lasting effects	H413: May cause long lasting harmful effects to aquatic life
Precautionary statement prevention	P273	P273	P273	P273
Precautionary statement response	P391	P391		
Precautionary statement storage				
Precautionary statement disposal	P501	P501	P501	P501

Figure 10: Extract from CLP classification and labelling requirements for hazards to the aquatic environment – acute and chronic
Source: CLP Regulation 1272/2008

Exclusion of the classification as proposed above is required in the GPP **core criteria** set. In the **comprehensive** set of criteria, beside the above given requirement, two additional ones are proposed. Firstly, purchased paints shall not be classified as respiratory or skin sensitizers. Secondly, the requirement regarding labelling as hazardous for the environment is made stricter to cover not only the classification (as in core criteria) as:

- H400 Very toxic to aquatic life,
- H410 Very toxic to aquatic life with long lasting effects,
- H411 Toxic to aquatic life with long lasting effects,

But also:

- H412 Harmful to aquatic life with long lasting effects.

Hazard classification addressed initially in the GPP **comprehensive criteria** are given in Table 30.

Table 30: Final product classification equivalence in CLP and DSD Directives addressed in GPP comprehensive criteria

CLP Mixture classification	DSD equivalent
Acutely toxic	T or T+
Specific Target Organ Toxicant	T, T+ or Xn
A respiratory or skin sensitizer	According to CLP labelling rules
A Carcinogen, Mutagen or Reproductive toxicant	Carcinogen, Mutagen or Reproductive toxicant categories 1-3
Hazardous to the environment (H400, H410, H411, H412)	N with the addition of R52-53 (H412) Harmful to aquatic life with long lasting effects

It is worth adding that in the EU Ecolabel criteria for paints and varnishes[101] requirements regarding ingredients and related hazards are much stricter than the ones proposed for GPP.

In the EU Ecolabel scheme the Regulation 66/2010[102] requires that:

> *The EU Ecolabel may not be awarded to goods containing substances or preparations/mixtures meeting the criteria for classification as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction (CMR), in accordance with Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, nor to goods containing substances referred to in Article 57 of Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency.*

The EU Ecolabel restricts a wide range of hazardous ingredients. The EU Ecolabel Competent Bodies have however the expertise to check and verify compliance of the products with such a criterion. This may not be the case for public procurers; therefore it is considered that a focus on the classification and labelling of the final product should be more straight forward and meaningful to verify. Whilst a limited number of ingredients are included in this criteria set (see also the criterion 1.4 below), the main focus is proposed to be on the overall products performance.

The same logic has been applied to the respective criteria set for road marking products.

Regarding the **verification** of compliance tenderers need to provide calculation for a tendered product (carried out in accordance with the rules provided in the CLP Regulation or alternatively (prior to 1st June 2015) in the DSD Directive) which confirm that the products to be supplied are not classified and do not require labelling as acutely toxic, specific target organ toxicant, a respiratory or skin sensitizer (for comprehensive criteria only), a carcinogen, mutagen or reproductive toxicant, or hazardous to the environment.

Follow-up from the stakeholders' consultation

The following comments were provided to the draft proposal:

- One of the stakeholders proposed to include the requirement on respiratory or skin sensitizers' properties in the core criteria, and not only comprehensive criteria, and similarly the exclusion of classification of the product as harmful to aquatic life with long lasting effects. It was emphasized that the requirements in the GPP are less strict then in the EU Ecolabel. This issue was addressed in the rationale section above. In order to keep the core

101 Available online at the project website: http://susproc.jrc.ec.europa.eu/paints/stakeholders.html; their adoption is foreseen in the coming weeks.

102 Regulation (EC) 66/2010 of the European Parliament and of the Council of 25 November 2009 on the EU Ecolabel, OJ 27 30.1.2010, p. 1.

criteria at lower ambition level than the comprehensive ones and in the light of no additional feedback on such changes, the current proposal is kept.

- It was also asked to restrict the respiratory sensitization and skin sensitization to indoor paints only. It is however proposed to keep it aligned with the EU Ecolabel criteria, as this is a precautionary measure specially set for the workers protection.
- It was asked to include the verification by means of Safety Data Sheets, which is also allowed in the EU Ecolabel. A respective statement was introduced.

Furthermore, as some stakeholders found the presentation of excluded hazards in the previous criteria draft a bit difficult to understand, in the revised criteria the table which presents the excluded hazards in a clearer way is proposed. The reference to DSD, as mentioned above, is now removed as from June 2015 the provisions of the DSD for the transition period expired.

Table 31: Final product classification addressed in GPP comprehensive criteria

Acute toxicity	Acute Tox. 1 Acute Tox. 2 Acute Tox. 3
Specific target organ toxicity – repeated exposure Specific target organ toxicity – single exposure	STOT RE 1 or 2 STOT SE 1, 2 or 3
Carcinogenicity	Carc. 1A Carc. 1B Carc. 2
Germ cell mutagenicity	Muta. 1A Muta. 1B Muta. 2
Reproductive toxicity	Repr. 1A Repr. 1B Repr. 2
Hazardous to the aquatic environment	Aquatic Acute 1
	Aquatic Chronic 1 or 2
	Aquatic Chronic toxicity 3
Respiratory sensitization	Resp. Sens. 1, 1A or 1B
Skin sensitization	Skin Sens. 1 , 1A or 1B

Following the developments in the EU Ecolabel one more issue was given into consideration in the current draft of the GPP criteria. Due to re-classification of 3-iodo-2-propynyl butylcarbamate (IPBC) which is used as dry film preservative in outdoor paints and varnishes, the final paint product becomes classified with category 3 chronic aquatic toxic. IPCB is added to protect the dry film from moulding and algae growth. According to information available, no equally effective alternatives to IPBC combinations exists on the market; therefore it is considered reasonable to exempt final product classification for outdoor paints and varnishes in which IPBC is used. In the current GPP in the **comprehensive criteria** section it is proposed to add the following note: *'The final product is allowed to be classified with H412 only in case of use of the following dry film preservative: 3-iodo-2-propynyl butylcarbamate (IPBC) combinations in outdoor paints and varnishes at concentration equal to or lower than 0.650%.* The same exemption is proposed also in the EU Ecolabel scheme in the form of amendment to the EU Ecolabel Decision.

5.1.1.1.4 Criterion 1.4 Hazardous ingredients

<table>
<tr><th>Core criteria</th><th>Comprehensive criteria</th></tr>
<tr><td colspan="2">TECHNICAL SPECIFICATIONS</td></tr>
<tr><td>1.4 Hazardous ingredients

The paint shall be compliant with the restrictions presented in Table 32, which either restrict the presence of or limit the concentration of the indicated hazardous substances in the paint.

Table 32 Paint hazardous ingredient requirements
<table>
<tr><th>Ingredient</th><th>Restriction or upper concentration limit</th></tr>
<tr><td>Preservatives:</td><td>Preservatives shall be non bio-accumulative[1].</td></tr>
<tr><td>Dry film preservatives:</td><td>Dry film preservatives shall not be intentionally used with the exception of:
- Indoor paints specifically required for high humidity areas with an upper concentration limit of 0.10% w/w
- Outdoor paints with an upper concentration limit of 0.30% w/w</td></tr>
<tr><td>Alkylphenolethoxylates: Alkylphenolethoxylates (APEOs) and their derivatives shall not be used in any paint or varnish preparations or formulations.</td><td>Shall not be intentionally used.</td></tr>
</table></td><td>1.4 Hazardous ingredients

The paint shall be compliant with the restrictions presented in Table 33, which either restrict the presence of or limit the concentration of the indicated hazardous substances in the paint.

Table 33 Paint hazardous ingredient requirements
<table>
<tr><th>Ingredient</th><th>Restriction or upper concentration limit</th></tr>
<tr><td>Preservatives:</td><td>Preservatives shall be non bio-accumulative[1].</td></tr>
<tr><td>Dry film preservatives:</td><td>Dry film preservatives shall not be intentionally used with the exception of:
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- Outdoor paints with an upper concentration limit of 0.30% w/w</td></tr>
<tr><td>Alkylphenolethoxylates: Alkylphenolethoxylates (APEOs) and their derivatives shall not be used in any paint or varnish preparations or formulations.</td><td>Shall not be intentionally used.</td></tr>
</table></td></tr>
</table>

Phthalates: Phthalates[103] identified as substances of very high concern and listed in the candidate list of the REACH Regulation[104] shall not be present in any paint or varnish preparations or formulations thereof.	0.1% w/w
Formaldehyde: Free formaldehyde in the white base, tinting base and colour tint[2]:	0.010% w/w
Metals: Cadmium, lead, chromium VI, mercury, arsenic, selenium.	0.010% w/w per metal or metallic complex/salt, as appropriate

[1] An ingredient is considered bio-accumulative when Log Kow ≤ 4.0 or bio-concentration factor (BCF) ≤ 500.
[2] In the case that a wide range of colour tints are to be used the bidder shall indicate which colour tint has the highest potential for formaldehyde release. A test report shall then only be requested for this tint.

Verification:

The tenderer shall provide appropriate documentation confirming compliance with the criterion, namely:

- for preservatives and APEOs: Safety Data Sheets for the product mixture.
- for phthalates: Safety Data Sheets for the product mixture for phthalates: Safety Data Sheets for the product mixture and/or a REACH Article 33(1)[105] declaration that is valid for the products.
- additionally for preservatives: a test report using OECD 305 Test Guideline can be used as an alternative to the

Phthalates: Phthalates[103] identified as substances of very high concern and listed in the candidate list of the REACH Regulation[104] shall not be present in any paint or varnish preparations or formulations thereof.	0.1% w/w
Formaldehyde: Free formaldehyde in the white base, tinting base and colour tint[2]; with the exception of where formaldehyde donors are required or are present in polymer dispersions, in which case the following value shall apply:	0.0010% w/w 0.010% w/w
Metals: Cadmium, lead, chromium VI, mercury, arsenic, selenium.	0.010% w/w per metal or metallic complex/salt, as appropriate
Isothiazolinones: Isothiazolinones MIT[3] CIT/MIT[4]	Sum total: 0.050% w/w 0.020% w/w 0.0015% w/w

[1] An ingredient is considered bio-accumulative when Log Kow ≤ 3.2 or bio-concentration factor (BCF) ≤ 100.
[2] In the case that a wide range of colour tints are to be used the bidder shall indicate which colour tint has the highest potential for formaldehyde release. A test report shall then only be requested for this tint.
[3] Methylisothiazolinone
[4] 5-chloro-2-methyl-4-isothiazolin-3-one (CIT) / 2- methyl-4-isothiazolin-3-one (MIT) in a ratio of 3:1

103 To meet this requirement, tenderers and/or their suppliers will need to screen the REACH Candidate List for phthalates. Although phthalates may be easy to identify as an ingredient because their function is generally as a plasticiser, not all phthalates that appear on the Candidate List are readily recognisable by their chemical name. It may therefore be useful to provide tenderers with a chemical definition. For this purpose they are defined as "a group of chemical compounds whose structural basis is an ester of phthalic acid (1,2-benzene dicarboxylic acid)".

104 ECHA, Candidate List of substances of very high concern for Authorisation, https://echa.europa.eu/candidate-list-table

105 Explanatory note: REACH Art 33(1) does not refer to mixtures (such as paints and most road markings formulations), but only to articles. Articles usually found in road markings that are not mixtures are structural plastic systems and preformed road marking products defined as tape, preformed cold plastic road marking or preformed thermoplastic road marking. In this case, Article 33 (1) of REACH applies: Under this article, suppliers (this also includes the professional shops from which the article is purchased and the article producers or importers) have to provide recipients (in this case procurers) information about the safe use of the article. As a minimum, shall be communicated to the recipient (in this case procurer) the name of the candidate list substance(s) that is in the article, if they are present in concentration of more than 0,1% of the article weight.

Safety Data Sheet for the sole purpose of confirming that the preservatives used are non-bioaccumulative. • for formaldehyde: a test report based on the Merckoquant method or high-performance liquid chromatography (HPLC) method (See Annex 2), • for metals: a test report based on ISO 3856 series or equivalent. Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.	**Verification:** The tenderer shall provide appropriate documentation confirming compliance with the criterion, namely: • for preservatives and APEOs: Safety Data Sheets for the product mixture. • for phthalates: Safety Data Sheets for the product mixture and/or a REACH Article 33(1)[107] declaration that is valid for the products. • additionally for preservatives: a test report using OECD 305 Test Guideline can be used as an alternative to the Safety Data Sheet for the sole purpose of confirming that the preservatives used are non-bioaccumulative. • for formaldehyde: a test report based on the Merckoquant method or high-performance liquid chromatography (HPLC) method (See Annex 2), • for metals: a test report based on ISO 3856 series or equivalent, • for isothiazolinones: Safety Data Sheets for the product mixture. Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.

Rationale

As mentioned above paint products contain a wide range of compounds, many of which have hazardous properties and can have harmful effects to human health and the environment. The most important ones; e.g. many preservatives, formaldehyde, phthalates and some metals, have been described in section 4.1.2.2.3 on hazardous substances. It is in general considered important to set restrictions on the use of certain hazardous substance groups in the "green" paints purchased by public authorities. The requirements on hazardous ingredients set in the EU Ecolabel scheme are very comprehensive. Intensive consultation in this area has been conducted along the EU Ecolabel criteria developments process. Restrictions of specific substances and substance groups, and respective limit values were discussed with industry, Member States and other interested parties. For more information on the process of setting these restrictions please consult the Technical Background Report – Revision of the EU European Ecolabel for Indoor and Outdoor Paints and Varnishes available at the JRC dedicated project website[106].

It was however considered too complex (and difficult to verify by the public authorities) to apply directly all the EU Ecolabel restrictions for the purpose of Green Public Procurement. Thus, the most important elements are proposed to be taken up. The chosen ingredients or their groups are of high concern due to their classification as either hazardous to the aquatic environment, acute toxins or CMR (carcinogenic, mutagenic, reproductive toxic).

106 Technical background report, October 2013, available online at: http://susproc.jrc.ec.europa.eu/paints/stakeholders.html.

In the **core criteria** this includes restriction on free formaldehyde, phthalates and metals (cadmium, lead, chromium VI, mercury, arsenic, selenium) above certain concentrations. In the last consultation round it was requested to introduce the restriction on alkylphenolethoxylates and their derivatives (currently covered under the comprehensive criteria) also in the core criteria. Alternatives to alkylphenolethoxylates exists and in some member states, e.g. Denmark, industry already in the middle of 1990's decided on a voluntary basis to eliminate their use[107].

In the **comprehensive criteria** a stricter approach is proposed. Beside more stringent limit value for free formaldehyde (0.0010% - aligned with the requirements in the new EU Ecolabel criteria for paints and varnishes, with exception of situation where formaldehyde donors are required or are present in polymer dispersions, in this case the 0.010% applies) also additional restrictions on the use of preservatives and isothiazolinones are proposed. These restrictions are based on intensive discussions, particularly in relation to the use of preservatives in paint products. Restricting their use is challenging as, although they are of concern as hazards to the aquatic environment, they constitute essential ingredients of paints and varnishes. The restriction adopted by the EU Ecolabel therefore needed to be carefully considered in order not to be too selective on the market.

For the restrictions it is proposed that the preservatives used shall not be bioaccumulative and any associated risk mitigation measures shall be implemented. In addition, use of dry film preservatives is only allowed in areas of high humidity and for outdoor applications. For isothiazolinones, in addition their total content, as well as content of specific preservatives is restricted due to their sensitizing properties.

Regarding **verification**, the tenderer shall provide appropriate documentation proving compliance with the requirements. The dossier can include Safety Data Sheets obtained from raw material suppliers. Additionally, for two of the substance groups chosen for restrictions (i.e. formaldehyde and metals) test methods have been specified to provide high level of assurance to procurers. For preservatives Safety Data Sheets or a test report using OECD 305 Test Guideline or equivalent shall be provided confirming that the preservatives used are non-bioaccumulative.

Follow-up from the stakeholders' consultation

Following the consultation process the following changes have been made:

- In the section regarding dry-film preservatives the specific restriction, aligned with the EU Ecolabel criteria was added. It was noted by the stakeholders if no dry-film preservatives are used in outdoor paints the coatings have a shorter life time, and require more frequent re-painting.
- In general the stakeholders asked to keep the comprehensive criteria and related limits for the hazardous ingredients (like phthalates, preservatives) equal to those of EU ecolabel criteria in order to avoid confusion.

In addition, the requirements on preservatives was introduced in core criteria (however, the less strict thresholds, aligned with the CLP values for BCF and log Kow shall be used, which makes the verification easier.)

One of the stakeholders stated that bio-accumulation is not always available and could create difficulty to the industry. Nevertheless, information regarding bioaccumulative potential is contained in the section 12 of Safety data Sheets in (Ecological information). This requirement is also aligned with the EU Ecolabel criteria and it gained stakeholders acceptance thus it is proposed to keep it. Alternatively, a test report using OECD 305 Test Guideline or equivalent shall be provided confirming that the preservatives used are non-bioaccumulative.

107 Possible Control of EU Priority Substances in Danish Waters – Technical and economic consequences examined by three scenarios, Environmental Project No. 1182, Danish Environmental Protection Agency, 2007, available online at: http://www2.mst.dk/common/Udgivramme/Frame.asp?http://www2.mst.dk/Udgiv/publications/2007/978-87-7052-566-4/html/default_eng.htm.

5.1.1.2 Criterion 2 Efficiency of application and durability

As shown in the section summarising the environmental assessment of paints (chapter 4.1) the in-use durability plays a key role in determining the environmental impact of paints. Paint performance during application and in use is very important, as it affects the amount of paint needed to cover a given surface and also impacts the frequency of repaints needed within a set time frame. These two aspects directly influence the environmental impact on the painting service and contribute to the overall environmental profile of the paint evaluated from a life cycle perspective.

Within this criteria area the requirements are proposed for the following aspects:

- Spreading rate,
- Wet scrub resistance (for indoor paints),
- Weathering resistance (for outdoor paints),
- Fungal and algal resistance (for outdoor paints),
- Abrasion resistance of floor paints (for indoor and outdoor paints).

They have been considered as the most important for ensuring high performance and durability of the paint products.

5.1.1.2.1 Criterion 2.1 Spreading rate

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	

2.1 Spreading rate

(same for core and comprehensive criteria)
(This specification is not applicable to varnishes, woodstains, transparent adhesion primers or any other transparent and semi-transparent coatings.)

The paint shall achieve an efficient spreading rate according to the applicable performance requirement in Table 34.

Table 34 Spreading rates for specific paint products

Type of paint	Spreading rate[1] (m^2/l)
White paints and light-coloured paints (including finishes and intermediates)	- indoor: 8 - outdoor: 6 - indoor & outdoor: 8
Tinting systems[2]	8
Primers and undercoats a. opaque b. with specific blocking/sealing, penetrating/binding properties c. with special adhesion properties	 8 6 6
Thick decorative coatings	1 m^2 per kg of product
Elastomeric outdoor paints	4

Notes:
[1] The spreading rates apply at a hiding power of 98%
[2] Only base should be tested

Verification:
The tender shall provide a test report using the following methods, or their equivalent:

- ISO 6504/1 (Paints and varnishes — determination of hiding power — Part 1: Kubelka-Munk

method for white and light-coloured paints);
- ISO 6504/3 (Part 3: determination of contrast ratio (opacity) of light-coloured paints at a fixed spreading rate);
- NF T 30 073 for paints specially designed to give a three-dimensional decorative effect or which are characterised by a very thick coat.

Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.

Rationale

A key environmental consideration is the amount of paint used during application. Minimising the amount of paint used, whilst achieving a high quality finish can result in a significant environmental saving. The most appropriate criterion by which this can be monitored is through the paints spreading rate. This criterion belongs to the most important one in the previous and in the current version of the EU Ecolabel for paints and varnishes, approved by the EU Ecolabel Regulatory Committee in November 2013 and adopted in May 2014 (Official Journal EU, 2014/312/EU).

Due to importance of this criterion, the same requirements as in the EU Ecolabel (the old and the new one, i.e. adopted in 2008 and in 2014) are asked for in the GPP **core and comprehensive criteria**. The consultation process did not allow for distinguishing between stricter values for the comprehensive than for the core ones. However, the high number of licenced products of the old EU Ecolabel criteria (already the ones from 2008) suggests that a sufficient share of the market can comply with this criterion, even if it is required in the core set.

This specification is not applicable to varnishes, woodstains, transparent adhesion primers or any other transparent coatings.

Regarding **verification**, the compliance with the above criterion should be demonstrated through a test report using the following methods, or their equivalent:

- ISO 6504/1 (Paints and varnishes — determination of hiding power — Part 1: Kubelka-Munk method for white and light-coloured paints)
- ISO 6504/3 (Part 3: determination of contrast ratio (opacity) of light-coloured paints at a fixed spreading rate),
- NF T 30 073 for paints specially designed to give a three-dimensional decorative effect or which are characterised by a very thick coat.

Follow-up from stakeholders' consultation

One of stakeholders commented that different values for trim paints could be given. The substantiating rationale was as follows: *"A trim paint can never be formulated above what is called Critical PVC (pigment volume concentration), whereas this is common practice for wall paints. The reason is that trim paints also cover high gloss materials (> 90 GU at 20°). The criterion for trim paints on hiding differ from wall paints, as for wall paints there is a difference in so-called wet- and dry- hiding. The wet hiding criterion is much more challenging from a formulation point of view. A good quality trim paint should be able to give a good wet hiding when a wet layer of 100um (or a dry layer of 40um) provides a Contrast Ratio of 99.5% (for white)".*

Nevertheless, as this issue was not raised during the EU Ecolabel criteria development, no proposal of the threshold and data substantiating it were provided and as the harmonisation of criteria is sought, it is proposed to keep the EU Ecolabel limit. Additionally, another stakeholder proposed to restrict the criterion to indoor products only, indicating that industry does not tests outdoor paints on a usual basis using the above approach. No alternative for testing was however provided, and as this criterion on is considered of high importance and the same requirements are set in the EU Ecolabel, it is proposed to keep them for both – indoor and outdoor products.

Regarding the **verification** process one of the stakeholders provided detailed feedback suggesting other testing methods which should be used. This information was consulted with the CEN TC 139,

and it is understood that there is none universal testing method. For instance EN ISO 3233, Paints and varnishes — Determination of percentage volume of non-volatile matter also can be used:

- Part 1: Method using a coated test panel to determine non-volatile matter and to determine dry film density by the Archimedes principle
- Part 2: Method using the determination of non-volatile-matter content in accordance with ISO 3251 and determination of dry film density on coated test panels by the Archimedes principle
- Part 3: Determination by calculation from the non-volatile-matter content determined in accordance with ISO 3251, the density of the coating material and the density of the solvent in the coating material

The three above methods differ depending on how the percentage volume of non-volatile matter and the density of the paint is determined.

According to the information received, the currently proposed method will be revised in the future and maybe then a reference to the new procedure should be done. For the moment it will be kept in the GPP criteria, as also done for the EU Ecolabel.

It shall however be remembered that beside the indicated in the criteria text methods also equivalent methods are allowed and can be used.

Follow up on the 3rd draft criteria

Stakeholders from one national association provided feedback that the proposed values for outdoor paints are too ambitious. They mentioned that due to variability of surfaces and in order to guarantee specific feature, like for instance impermeability, sometimes a number of coatings is needed. The will collect market information on the strictness of this criterion. The same refers to elastomeric outdoor paints, which can have longer life time than other types of paints. Life time is one of the features which should be taken into account by the procurer while deciding about the choice of a specific type of paint. Nevertheless, no further technical information supporting the above-written have been provided to the project team.

5.1.1.2.2 Criterion 2.2 Wet scrub resistance (indoor paints)

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
	2.2 Wet scrub resistance (only indoor paints) *(For applications where cleanability and scrub resistance are required)* *(This requirement does not apply to transparent and semi-transparent coatings.)* Wall paint for which wet scrub resistance is requested in the tender shall achieve Class 1 or 2 in wet scrub resistance according to EN 13300 and EN ISO 11998 or their equivalent. Exempted are matt indoor wall and ceiling paints with white pigment content equal or lower than 25g/m^2 of dry film. This requirement only applies to tinting bases (base paints).

	Verification: The tenderer shall provide a test report according to EN 13300 using the method EN ISO 11998 (Test for cleanability and scrub resistance) or equivalent. Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply. *A core criterion is not proposed, nevertheless, if the procured paint will be used on surfaces which will be intensively cleaned, public procurers are encouraged to use the comprehensive criterion.*

Rationale

In accordance with the EN 13300[108] wet scrub resistance (WSR) evaluates the resistance of the coating to repeated cleaning. It is determined in accordance with the procedure described in the ISO 11998 standard after a drying period of 28 days at (23±2)°C and (50±5) % relative humidity. WSR is classified according to the loss of thickness of the coat, as follows:

- Class 1 < 5 µm at 200 scrubs,
- Class 2 >5 µm and < 20 µm at 200 scrubs,
- Class 3 >20 µm and < 70 µm at 200 scrubs,
- Class 4 < 70 µm at 40 scrubs,
- Class 5 >70 µm at 40 scrubs.

WSR is considered one of the factors used to determine the durability of a particular paint. Manufacturers state that this is one of the key performance indicators for hard wearing paints (particularly floor and bathroom/kitchen paints). The durability of paint is important in reducing its environmental impact. As is shown within the LCA in the background report[109], any increase in time between repaints, in this case due to an increase in wear resistance, leads to a decrease in the overall lifecycle impact of the paint.

A lengthy debate over the inclusion and scale of this requirement preceded the development of the current criterion for the EU Ecolabel. A key concern was whether tests need to be carried out for all paints or only for those claiming wet scrub resistance. From an environmental perspective, more durable paints would reduce the environmental impact by increasing intervals between repainting which is also related to lower energy consumption/waste production.

However, the proposed universal requirement that all paints must meet this target was opposed because it would exclude most matt wall paints and was seen as unnecessary for some types of paints, e.g. wood and trim paints.

In the EU Ecolabel criteria, after intensive discussions, it was agreed to combine the criterion on white pigment and WSR as follows:

108 EN 13300 Paints and varnishes - Water-borne coating materials and coating systems for interior walls and ceilings – Classification.
109Available online at the project website:
http://susproc.jrc.ec.europa.eu/paints/docs/131021%20Ecolabel%20paints_EUEB%20vote_Technical%20report%20final.pdf.

Criterion 1. White pigment and Wet Scrub Resistance (of the EU Ecolabel)

1(a) Minimum requirement for white pigment content:

Indoor wall and ceiling paints for which Class 1 and 2 wet scrub resistance claims are made shall have a white pigment content (white inorganic pigments with a refractive index higher than 1,8) per m^2 of dry film equal to or lower than that described in Table 1, with 98 % opacity. This requirement only applies to tinting bases (base paints).

Table 35: Relationship between wet scrub resistance and TiO_2 content for indoor paints in EU Ecolabel

Wet scrub resistance	***Indoor limit (g/m^2)***
Class 1	*40*
Class 2	*36*

For all other paints, including limed paints, silicate paints, primers, anti-rust paints and facade paints, the white pigment content (white inorganic pigments with a refractive index higher than 1,8) shall not exceed 36g/m^2 for indoor products and 38g/m^2 for outdoor products. In the case of paints for both indoor and outdoor use the more stringent limit shall apply.
In case the above mentioned products fall under the exemption indicated in part (b) then the white pigment content(white inorganic pigments with a refractive index higher than 1,8) shall not exceed25 g/m^2 of dry film, with 98 % opacity.

1(b) Minimum requirement for Wet Scrub Resistance (for indoor paints only)

All indoor wall and ceiling paints (finishes) shall achieve class 1 or class 2 in wet scrub resistance (WSR) according to EN 13300 and EN ISO 11998. This requirement only applies to tinting bases (base paints).
Exempted from this requirement are indoor wall and ceiling paints with a white pigment content (white inorganic pigments with a refractive index higher than 1,8) that is equal or lower to 25g/m^2 of dry film, with 98 % opacity.
Only WSR class 1 and 2 ecolabelled paints may claim wet scrub resistance on the label or other marketing documentation.

However, in order to simplify the formulation and facilitate the verification of criteria for public procurers it is considered more appropriate to keep both requirements separately in the core and comprehensive GPP criteria set (as it was also done in the previously valid EU Ecolabel for indoor paints). It is proposed for the **comprehensive criterion** only to align it with the new EU Ecolabel decision from 2014. It would be then required that the wall and ceiling paint finish shall achieve class 1 or 2 in wet scrub resistance according to EN 13300 and tested using EN ISO 11998 or equivalent method. Exempted are matt indoor wall and ceiling paints with white pigment content equal or lower than 25g/m^2 of dry film. This requirement only applies to tinting bases (base paints).
A **core criterion** is not proposed, nevetheless, if the procured paint will be used on surfaces which will be intensively cleaned, public procurers may still wish to use the comprehensive criterion.

Regarding **verification** of compliance with the comprehensive criterion a test report according to EN 13300 using the method EN ISO 11998 (test for cleanability and scrub resistance) or their equivalent shall be provided by the tenderer.

Follow-up from the stakeholders' consultation

Limited feedback was received regarding this criterion. Only one stakeholder asked whether trim and ceiling paints could be exempted from this requirement, as they will not usually be cleaned/ scrubbed. Trim paints were not however covered under the previous version of the criteria and no change is needed. Regarding ceiling paints the comment was accepted and if paint is marketed exclusively for painting of ceilings, WSR is not required. A respective amendment was introduced.

Furthermore, one stakeholder asked for addition of class 3 in the criterion. But as explained above the alignment with the EU Ecolabel criteria is sought and the current proposal is kept. Also other stakeholder association confirmed that paints with a wet scrub class lower than a 2 are not suitable for public areas.

5.1.1.2.3 Criterion 2.3 Weathering resistance (outdoor paints)

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	

2.3 Weathering resistance (only outdoor paints)

(same for core and comprehensive criteria)

Masonry, wood and metal paints shall demonstrate resistance to the possible forms of weathering-induced deterioration in Table 36.
Masonry paints shall be exposed to artificial test conditions for 1000 hours, wood and metal paints for 500 hours.
This shall be demonstrated according to the recommended test methods, or their equivalent, under artificial weathering conditions. Corrosion resistance for metal paints shall also include blistering.
Tests should be performed on the tinting base.

Table 36 Weathering resistance tests

Weathering induced deterioration	Performance requirement	Recommended test
Decrease of gloss[1]	Less than or equal to 30% of its initial value	ISO 2813
Chalking	1,5 or better (0,5 or 1,0)	EN ISO 4628-6
Flaking	Flake density 2 or less, flake size 2 or less	ISO 4628-5
Cracking	Crack quantity 2 or less, crack size 3 or less	ISO 4628-4
Blistering	Blister density 3 or less, blister size 3 or less.	ISO 4628-2
Corrosion[2]	Rusting equal to or better than Ri2.	ISO 4628-3

[1]Not applicable to mid-sheen and matt-finishes (refer to Annex 1 for details).
[2]For anti-rust paints.

Verification:
The tenderer shall provide test results demonstrating performance of the paint according to the requirements listed in Table 36.
With the exception of corrosion for metal paints the artificial weathering conditions shall reflect the conditions described in ISO 11507 or (for outdoor wood finishes) QUV accelerated weathering apparatus with cyclic exposure with UV(A) radiation and spraying according to EN 927-6 or their equivalent.
For corrosion the relevant atmospheric corrosivity categories in EN ISO 12944-2 and the accompanying procedures specified in EN ISO 12944-6, or equivalent, shall be used. Anti-rust paints for steel substrates shall be tested after 240h salt spray following ISO 9227 or equivalent.
Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.

Rationale

Exterior surfaces are often exposed to various conditions, which contribute to weathering. Changes in temperatures, exposure to sun and rainfall are the main factors to be mentioned. This exposure can result in change of the general appearance, change of colour/gloss or other effects like: chalking, cracking, blistering, adhesion and flaking (see Table 37 for explanations).

Table 37: Effects of paint weathering process

Blistering	Formation of dome-shaped projections in paints or varnish films resulting from local loss of adhesion and lifting of the film from the underlying surface. It can occur due to surface exposure of paint to strong sunshine. Can be assessed according to ISO 4628-2.
Chalking	Appearance of a loosely adherent fine powder on the surface of a film arising from the degradation of one or more of its constituents. Occurs e.g. due to exposure of UV radiation in sunshine. Can be assessed according ISO 4628-6 or 4628-7.
Cracking	Occurs due to the unequal expansion or contraction of paint coats. It usually happens when the coats of the paint are not allowed to cure/dry completely before the next coat is applied. Can be assessed according to ISO 4628-4.
Flaking	The detachment of pieces of paint from the substrate, caused by a loss of adhesion and elasticity. Can be assessed according to ISO 4628-5.
Rusting (corrosion)	Chemical destruction of the paint film caused by the process corrosion. Can be assessed according to ISO 4628-3.

Source: Based on ISO 4628 series and Glossary of Terms - American Coatings Association[110]

In order to evaluate weathering resistance of a paint product *'coatings from paints, varnishes and similar materials are weathered in the laboratory, in order to simulate ageing processes occurring during natural weathering. Artificial weathering of coatings using fluorescent UV lamps and condensation or water spray is carried out in order to produce a certain radiant exposure or mutually agreed total number of operation hours, a given degree of a change in a property or properties. The properties of the exposed coatings are compared with those of unexposed coatings, prepared from the same coating materials under identical conditions, or with coatings whose degradation properties are known. Radiation, temperature and humidity all contribute to the ageing process. Therefore, apparatus specified in this standard simulates all three factors'*.[111]

Based on the results of the consultation conducted with industry and all involved stakeholders requirements for weathering resistance were placed for the recently voted EU Ecolabel scheme. Due to the importance of this feature, GPP criteria are aligned with them, for both - core and comprehensive criteria sets. The only difference between these two is that in the **core criteria** masonry paints shall be exposed to artificial test conditions for 1000 hours (i.e. it is aligned with the 2008 EU Ecolabel criteria), while wood and metal paints for 500 hours. In the **comprehensive criteria** period of 1000 hours applies to all kinds of paints (it is aligned with the 2014 EU Ecolabel

110 Glossary of Terms - American Coatings Association, available online at: https://www.paint.org/about-our-industry/glossary.html, accessed April 2014.

111 ISO/FDIS 11507:2006 Paints and varnishes - Exposure of coatings to artificial weathering - Exposure to fluorescent UV lamps and water.

criteria). The paints shall demonstrate resistance to the possible forms of weathering-induced deterioration fulfilling the performance requirements indicated in Table 38.

Table 38: Weathering resistance tests

Weathering induced deterioration	**Performance requirement**	**Recommended test**
Decrease of gloss[2]	Less than or equal to 30%of its initial value	ISO 2813
Chalking	1,5 or better (0,5 or 1,0)	EN ISO 4628-6
Flaking	Flake density 2 or less, flake size 2 or less	ISO 4628-5
Cracking	Crack quantity 2 or less, crack size 3 or less	ISO 4628-4
Blistering	Blister density 3 or less, blister size 3 or less.	ISO 4628-2
Corrosion[3]	Rusting equal to or better than Ri2.	ISO 4628-3

Notes:
[1]Not applicable to varnishes and bases.
[2]Not applicable to mid sheen and matt-finishes with an initial gloss value less than 60% at 60^0 angle of incidence.
[3]For anti-rust paints.

Regarding **verification** tests for weathering resistance (as indicated in Table 38) shall be conducted. A test report using above specified methods (or their equivalent) shall be provided by the tenderer.

The artificial weathering conditions shall reflect the conditions described in ISO 11507 or (for outdoor wood finishes) QUV accelerated weathering apparatus with cyclic exposure with UV(A) radiation and spraying according to EN 927-6 (with the exception of corrosion for metal paints).

For corrosion the relevant atmospheric corrosivity categories in EN ISO 12944-2 and the accompanying procedures specified in EN ISO 12944-6, or equivalent, shall be used. Anti-rust paints for steel substrates shall be tested after 240h salt spray following ISO 9227.

Follow-up from stakeholders' consultation

Tests proposed for verification of the criteria for weathering have been consulted with CEN TC 139 and updated as given in Table 38.

It was clarified that:

- **Artificial weathering** of paints and varnishes is described in EN ISO 16474*, Paints and varnishes — Methods of exposure to laboratory light sources:*
  — *Part 1: General guidance*
  — *Part 2: Xenon-arc lamps*
  — *Part 3: Fluorescent UV lamps*
  ISO 16474-1 to part 3 are replacing EN ISO 11507 (Fluorescent lamps) and EN ISO 11341 (xenon-arc lamps).
- The actual horizontal standards for **colorimetry** are EN ISO/CIE 11664, *Colorimetry:*
  — *Part 1: CIE standard colorimetric observers*
  — *Part 2: CIE standard illuminants*
  — *Part 3: CIE tristimulus values*
  — *Part 4: CIE 1976 L*a*b* Colour space*
  — *Part 5: CIE 1976 L*u*v* Colour space and u', v' uniform chromaticity scale diagram*
  — *Part 6: CIEDE2000 Colour-difference formula*
- The actual vertical standards for colour measurement are ISO 18314*, Analytical colorimetry:*

- *Part 1: Practical colour measurement*
- *Part 2: Saunderson correction, solutions of the Kubelka-Munk equation, tinting strength, hiding power*
- *Part 3: Special indices*

➢ ISO 7724-1 to -3 are withdrawn.
➢ EN ISO 2813 on gloss measurement and all parts of EN ISO 4628 are still valid.

Appropriate amendments were introduced. Additionally, the requirement regarding colour change was removed from the above criterion, as the testing proposed seems unsuitable and no better alternative has been agreed so far.

5.1.1.2.4 Criterion 2.4 Resistance of paint against fungi and algae (only outdoor paints)

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
2.4 Fungal and algal resistance of the film (only outdoor paints) *(Same for core and comprehensive criteria)* *(For applications where fungal and algal resistance of the film are needed)* Base paints used for exterior masonry and wood and for which fungal and/or algal resistant properties are needed shall meet the requirements in Table 39. **Table 39 Fungal and algal resistance** **Application** / **Fungal resistance** / **Algal resistance** Masonry / Class 1 or lower / Score of 0 Wood / Class 1 or lower / Score of 0 **Verification:** The tenderer shall provide test results demonstrating compliance according to the test methods EN 15457 and/or EN 15458, or their equivalent. For coatings containing encapsulated dry-film biocides altered conditioning protocols shall also be accepted. Manufacturers shall provide information about any variation in conditioning along with test results of the EN 15457 and/or 15458 standards. Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.	

Rationale

Microorganisms can grow in liquid paints prior to and after the application. Manufacturers, in order to prevent this growth use biocides. Some of them are in-can preservatives, which are used in order to prevent the growth of microorganisms during storage of the product. Other are added to the paint to protect the applied paint (the so called film preservatives). And finally, biocides contained in the product can also have a function of imparting antimicrobial activity to the coating (producing an antimicrobial coating).[112]

112 Introduction to the Microbiology of Coatings, PRA Coatings Technology Centre, available online at: http://www.pra-world.com/technical_services/laboratory/microbiology/introduction, accessed April 2014.

Dry conditions do not favour the growth of microorganisms, while wet (at least periodically) surfaces constitute good environment for their development. Without proper protection, coatings quality can deteriorate. The growth of microorganisms, like e.g. algae or fungi, on the external walls of buildings can result in discoloration of the painted surface and its physico-chemical deterioration; microorganisms can penetrate the surface damaging it, making it more permeable. Further, the development under the film can cause loss of adhesion of the coating. Algal growth on painted wood is a sign that the underlying wood is rotting.[113]

Setting a requirement regarding fungal and algal resistance of the film is considered important for outdoor paints, for example, wood paints, in order to ensure the quality and durability of the painted surfaces. Along the consultation process, it was requested for all outdoor coatings that claim fungal and algal resistance that specific testing of fungal and algal resistance is performed. The same formulation of the criterion (aligned with the EU Ecolabel criteria) is proposed as **core and comprehensive**.

Regarding **verification**, the compliance shall be verified by testing in accordance with test methods described in EN 15457 and/or EN 15458, or their equivalent.

Follow-up from stakeholders' consultation

Following stakeholder's remarks the criteria are now aligned with the EU Ecolabel ones.

One stakeholder commented also that the test method used for fungal and algae resistance have very low correlation to the real life performance of the products and that many modern formulations with encapsulated biocides might not fulfil the criteria. In the recent years research has been conducted regarding the release of biocides from the paint film and comparison between free and encapsulated biocides[114,115,116] showing significant reduction of the release of the biocides from the film to the environment when the encapsulation technology is applied.

In the stakeholders feedback provided and further consultation conducted with industry concerns were raised that the modern encapsulated biocides would mostly probably not pass the proposed tests, which were developed for conventional, free biocides. The following explanation was provided by the association: "*The crucial point is that for truly encapsulated dry-film biocides a longer preconditioning time of the dried coating prior to testing usually may be required. This is in order to allow the migration of actives out of the capsule and thus making them bioavailable at the coating´s surface before inoculating it with fungal and algal organisms*".

Point 7.3 of the 15457 Conditioning of the test samples states that:

Condition the test sample in a horizontal position for at least 5 days at (23 ± 2) °C and (50 ± 5) % relative humidity, in accordance with EN 23270.

NOTE: The conditioning time might vary according to the coating material and end use corresponding to information given by the manufacturer.

Industry provided a proposal that a phrase is added in the criteria which would state that altered conditioning protocols which might be necessary for coatings containing encapsulated dry-film biocides shall also be accepted. Manufacturers shall provide information about any variation in conditioning as outlined in § 8 g) along with test results of the EN 15457 and 15458 standards. A

113 Gaylarde P. M., Gaylarde C. C., Algae and cyanobacteria on painted surfaces in Southern Brazil, Rev. Microbiol. vol.30 n.3 São Paulo July/Sept. 1999.

114 Breuer K., Mayer F., Scherer K., Schwerd R., Sedlbauer K., Wirkstoffauswaschung aus hydrophoben Fassadenbeschichtungen: verkapselte versus unverkapselte Biozidsysteme, Bauphysik 34 (2012), Heft 1.

115 Burkhardt, M, Dietschweiler, C, Campiche, S, Junghans, M, Schifferli, A, Baumberger, D, Kienle, C, Vermeirssen, E, Werner, I (2013): Ecotoxicological Assessment of Immersion Samples from Façade Render. Report for the Swiss Federal Office for the Environment FOEN, Bern, p. 34.

116 Schoknecht U., On the face of it – Leaching of actives from façades – current knowledge and actions European Coatings JOURNAL 03, 2014, p. 18.

respective statement is added in the revised proposal in order to ensure that state-of-the-art-biocides are accepted in GPP compliant products.

5.1.1.2.5 Criterion 2.5 Abrasion resistance of floor paints (indoor and outdoor paints)

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
2.5 Abrasion resistance of floor paints *(Same for core and comprehensive criteria)* Floor coatings and floor paints shall demonstrate an abrasion resistance not exceeding 70 mg weight loss after 1000 test cycles with a 1000 g load and a CS10 wheel according to EN ISO 7784-2. **Verification:** The tenderer shall provide test results carried out according to EN ISO 7784-2 or equivalent. Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.	

Rationale

Abrasion resistance can be defined as the ability of a material to withstand mechanical activity (like rubbing, scraping or erosion), which progressively removes the material from the surface. This is a very important feature of the coating from the point of view of maintaining material's original appearance and structure. The better the abrasion resistance, the less frequent the need to repaint the surface and thus, the lower the overall environmental impact of the paint in a life cycle perspective. Due to this reason, it is proposed to set **core and comprehensive** criteria in this area. Consultation process resulted in the following formulation (aligned with the EU Ecolabel criteria): Floor coatings and floor paints shall demonstrate an abrasion resistance not exceeding 70 mg weight loss after 1000 test cycles with a 1000 g load and a CS10 wheel according to EN ISO 7784-2.[117]

Regarding **verification**, the tenderer shall provide a test results carried out according to EN ISO 7784-2[118] or equivalent.

5.1.1.2.6 Criterion 2.6 Packaging

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
2.6 Packaging *(Same for core and comprehensive criteria)* Paints shall be delivered in containers of (no smaller than) *X* litres (*to be decided by the public*	

117 ISO 7784-2 Paints and varnishes - Determination of resistance to abrasion - Part 2: Rotating abrasive rubber wheel method.
118 Paints and varnishes - Determination of resistance to abrasion - Part 2: Rotating abrasive rubber wheel method.

authority in order to reduce packaging).

Verification:
The tenderer shall declare that paints will be supplied in containers compliant with the above mentioned requirement.

Rationale

The reduction in packaging of the paint has a significant environmental impact and shall be strived for.

A WRAP study from 2011 analysed alternative supply chain approaches for paints in the UK.[119] The study concluded that the concept of distributing paint in bulk is not a new one – for more than 10 years some companies use it already, but these systems are not wide spread yet. In general, the manufacturer provides the product in bulk to the point of sale, where is it dispensed to customer-tailored sizes of packaging. Beside the bulk delivery, the authors identified practices of dispensing into refillable packaging (which is however suitable more for frequent purchasers). The results of the WRAP study showed that bulk distribution can be both environmentally and economically beneficial. The reduction in packaging waste, when using the bulk distribution, can contribute to significant greenhouse gases emissions reduction (95% of saving in embedded carbon impacts) and financial saving of around 30%.

One of the examples of bulk delivery can be Dulux Trade Bulk Packaging Solution[120]. AkzoNobel developed for their decorative paint bulk packaging system. This system is especially useful for large works, as instead of typical 10 l paint containers 500 l container can be used and moved around the site. It fulfils the function of a store of paint, which can be directly decanted into scuttles via a bulge pump.

There are, some important factors which need to be taken into account in the case of such packaging systems. They include:

- Appropriate storage conditions,
- Frequent use (due to difficulties in maintaining of rheology for some types of paints),
- Ensuring the appropriate pressure in the bulk container (a pump may be needed to decent the product in an efficient way).

In order to minimise environmental impacts related to paint packaging it is proposed to require that points are awarded for the tenderers that will minimise packaging waste per volume of paint supplied. It is envisaged that the best performance will be achieved by using larger containers (**core and comprehensive criteria**).

5.1.2 AWARD CRITERIA FOR PAINTS AND VARNISHES

According to the Communication 2008(400) "Public procurement for a better environment":

"Some of the GPP criteria may also be formulated as environmental award criteria, to stimulate additional environmental performance without being mandatory and therefore without foreclosing the market for products not reaching the proposed level of performance. Award criteria, if given a significant weighting, may however give an important signal to the market place".

119 Lee P., Willis P, WRAP, Paint and woodcare products – distribution and delivery – A review of alternative supply chain approaches within UK paint and woodcare markets, Final Report, 2011.
120 For more details see: http://ccsbestpractice.org.uk/wp-content/uploads/2015/09/Bulk-Paint-Containers.pdf

Contracting authorities have to indicate in the contract notice and tender documents how many additional points will be awarded for each award criterion. Environmental award criteria should, altogether, account for at least 10 to 15 % of the total points available. Where the award criterion is formulated in terms of "better performance as compared to the minimum requirements included in the technical specifications", points will be awarded in proportion to the improved performance.

5.1.2.1 Criterion 1 Content of Semi Volatile Organic Compounds

<table>
<tr><th>Core criteria</th><th>Comprehensive criteria</th></tr>
<tr><td colspan="2">AWARD CRITERIA</td></tr>
<tr><td></td><td>
1. Content of Semi-Volatile Organic Compounds

Points shall be awarded if the paint product has a content of Semi-Volatile Organic Compounds (SVOCs) equal to less than the limits given in Table 40.

The content of SVOCs shall be determined for the ready-to-use product and shall include any recommended additions prior to application such as colourants and/or thinners.

Table 40 SVOC content limits
<table>
<tr><th>Product description (with subcategory denotation according to Directive 2004/CE/42)</th><th>SVOC limits (g/l including water)</th></tr>
<tr><td>a. Interior matt walls and ceilings (Gloss <25@60°)</td><td>30 [1]/ 40 [2]</td></tr>
<tr><td>b. Interior glossy walls and ceilings (Gloss >25@60°)</td><td>30 [1]/40 [2]</td></tr>
<tr><td>c. Exterior walls of mineral substrate</td><td>40</td></tr>
<tr><td>d. Interior/Exterior trim and cladding paints for wood and metal</td><td>50 [1]/60 [2]</td></tr>
<tr><td>e. Interior trim varnishes and woodstains, including opaque woodstains</td><td>30</td></tr>
<tr><td>e. Exterior trim varnishes and woodstains, including opaque woodstains</td><td>60</td></tr>
<tr><td>f. Interior and Exterior minimal build woodstains</td><td>30 [1]/40 [2]</td></tr>
<tr><td>g. Primers</td><td>30 [1]/40 [2]</td></tr>
<tr><td>h. Binding primers</td><td>30 [1]/40 [2]</td></tr>
<tr><td>i. One-pack performance coatings</td><td>50 [1] /60 [2]</td></tr>
<tr><td>j. Two-pack reactive performance coatings for specific end use such as floors</td><td>50 [1] /60 [2]</td></tr>
<tr><td>Decorative effect coatings</td><td>50 [1] /60 [2]</td></tr>
<tr><td>Anti-rust paints</td><td>60</td></tr>
</table>
Notes:
1 Indoor white paints and varnishes
2 Indoor tinted paints / outdoor paints and varnishes

Verification:
The tenderer shall provide either:
a) a calculation of the SVOC content, supported, if available, by Safety Data Sheets or;
</td></tr>
</table>

	b) a test report carried out according to ISO 11890-2. Additionally, the test modifications provided in Annex 3 shall be used. Products which have been awarded the EU Ecolabel for paints and varnishes, as established in Commission Decision (EU) 2014/312/EU are deemed to comply.

Rationale

There are several definitions of VOC and semi volatile organic compounds (SVOCs) being used. The World Health Organisation has defined SVOCs as organic compounds with boiling points ranging from 240 °C to 400 °C.[121] For the purpose of the EU Ecolabel criteria SVOCs were further defined as any organic compound having a boiling point greater than 250 °C and less than 370 °C measured at a standard pressure of 101,3 kPa and which, in a capillary column are eluting with a retention range after n-Tetradecane (C14H30) and up to and including n-Docosane (C22H46).

The decline in use of VOCs has led to an increase in the use of SVOC's. Construction and building products are a major source of SVOCs and the Construction Products Directive[122] has an optional criterion that SVOCs need to be avoided within the sector.[123,124] The major issue is that SVOC's can redistribute themselves from one surface, such as paints, onto other surfaces, from which they can be inhaled and ingested.[125]

Presence of semi volatile organic compounds (SVOC) in the indoor environment gained in the recent time special interest due to the rising health concerns related to those compounds. Some of them, e.g. polycyclic organic hydrocarbons (PAHs), are known to be carcinogenic. Other may contribute to asthma, allergies, and other bronchial irritations. Possible exposure routes to SVOCs are skin contact with surfaces, aerosol deposition on skin and respiratory intake.[126]

It is therefore proposed to set a **comprehensive award criterion** to support purchase by public authorities of products with lower SVOC content. This criterion is aligned with the EU Ecolabel criterion. SVOCs are also addressed in the Blue Angel criteria for paints.

Regarding **verification**, in order to ensure the alignment between the EU GPP and EU Ecolabel instruments, it is proposed to request either a test report, which provides a simpler form of verification for procurers, or calculations, which are be more complicated and require expertise to verify but are permitted in the EU Ecolabel.

Follow-up from the stakeholders' consultation

Following the stakeholders comments, similarly like for the VOC emissions a possibility to provide the calculation should be given in order to align the criteria with the EU Ecolabel criteria. It was

121 WHO, World Health Organization. 1997. Environmental Health Criteria 192, International programme on chemical safety. Geneva. 81 p. ISBN 9241571926.

122 Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products, OJ L 40, 11/02/1989, p. 12.

123 Scutaru A. M., Keirsbulck M., Tirikkonen T., Sperk C., Funch L. W., Horn W., Maupetit F., Saarela K., Kephalopoulos S., Sateri J., Crump D., Witterseh T., Daeumling Ch., European Collaborative Action. Urban air, indoor environment and human exposure, Report No 27; Harmonisation framework for indoor material labelling schemes in the EU, 2010.

124 CEN/TC 351 Construction products: Assessment of the release of dangerous substances.

125 de Oliveira Fernandes E., Jantunen M., Carrer P., Seppänen O., Harrison P., Kephalopoulos S., EnVIE; Coordination Action on Indoor air Quality and Health Effects, Final Report, 2010, available online at: http://cordis.europa.eu/documents/documentlibrary/126459681EN6.pdf, accessed May 2014.

126 Järnström H., Vares S., Airaksinen M., Semi volatile organic compounds and flame retardants, Occurrence in indoor environments and risk assessment for indoor exposure, VTT RESEARCH NOTES 2486, available online at: http://www.vtt.fi/inf/pdf/tiedotteet/2009/T2486.pdf; accessed May 2014.

stated that if testing at external institutes was required, that would very much increased the costs for the paint suppliers.

The thresholds proposed are aligned with the requirement set in the EU Ecolabel criteria. Some industry stakeholders agreed with them while others considered them too restrictive; however no supportive technical information was provided and the current values are proposed to be kept.

5.1.2.2 Criterion 2 Indoor Air Quality: Indoor paints

<table>
<tr><th>Core criteria</th><th>Comprehensive criteria</th></tr>
<tr><td colspan="2">AWARD CRITERIA</td></tr>
<tr><td>2. Indoor Air Quality: Indoor paints

Points shall be awarded to products with emissions (of TVOCs or Formaldehyde or both) lower than the limits indicated in Table 41.

Table 41 Indoor paint emissions to air limits
<table>
<tr><th rowspan="2">Product</th><th colspan="2">Emissions limits (µg/m³)</th></tr>
<tr><th>3 days</th><th>28 days</th></tr>
<tr><td>TVOC's[1]</td><td>10,000</td><td>2,000</td></tr>
<tr><td>Formaldehyde</td><td>-</td><td>120</td></tr>
</table>
[1]Total Volatile Organic Compounds

Verification:
The tenderer shall provide test reports based on analytical testing according to EN 16402 or equivalent.</td><td>2. Indoor Air Quality: Indoor paints

Points shall be awarded to products with emissions (of TVOCs or Formaldehyde or both) lower than the limits indicated in Table 42.

Table 42 Indoor paint hazardous emissions to air limits
<table>
<tr><th rowspan="2">Product</th><th colspan="2">Emissions limits (µg/m³)</th></tr>
<tr><th>3 days</th><th>28 days</th></tr>
<tr><td>TVOC's</td><td>10,000</td><td>1,500</td></tr>
<tr><td>Formaldehyde</td><td>-</td><td>60</td></tr>
</table>
[1]Total Volatile Organic Compounds

Verification:
The tenderer shall provide test reports based on analytical testing according to EN 16402 or equivalent.</td></tr>
</table>

Rationale

As mentioned in the section regarding indoor air quality in the environmental evaluation chapter (see chapter 4.1.3) already in the studies conducted in the 1980's[127] contamination of indoor air by most commonly encountered VOC's was several times higher indoor than in the outside air, regardless of the environment (whether rural or industrial). The quality of indoor air is important especially for the human health (VOCs can contribute to health concerns, like asthma, allergies, and bronchial irritations) but also well-being (at home and in the work place).

New legislation, in particular regulations in France and Germany pushes paints manufacturers toward testing of indoor air quality (IAQ). This issue is also important from the perspective of buildings certification with regards to emissions into the internal environment. An IAQ criterion is currently proposed for the EU GPP criteria for office buildings and includes requirements for paints and varnishes. A range of certification schemes also exists for building materials and products, including schemes in Scandinavia, Germany, Austria, France and the USA, which combine substance specific lowest concentration of interest LCIs with TVOCs[128] and SVOCs requirements.

127 EPA's Office of Research and Development's, 'Total Exposure Assessment Methodology (TEAM) Study', Volumes I through IV, 1985.
128 TVOC = total volatile organic compounds

Recognising the importance of this area it is proposed to set an **award criterion** in both –**core and comprehensive** criteria sets for greener public procurement. Limit values in the core criteria are aligned with selected emission values from B class of the French scheme[129], while the values for comprehensive criteria correspond to the A class.

The **verification** of the compliance with this requirement shall be conducted through analytical testing according to EN 16402[130] or equivalent.

Follow-up from the stakeholders' consultation

Some stakeholders welcomed the introduction of this new criterion and proposed even to have it as a core one, while others had some additional queries or mentioned that VOC and SVOC are already restricted in the criteria. The criteria on SVOC and IAQ are however an award criterion, not technical specifications, and thus it is considered appropriate to keep both to give more flexibility to the applicants. The proposed IAQ thresholds are based on the French system but also correspond to the work of the JRC towards a harmonised European level.

For testing it was proposed to define the air ventilation rate as being 0.5 $m^3/(m^2h)$ and that the limit values of the award criterion are connected to this (for example the limit values of formaldehyde emission testing of new ecolabel criteria were established under air ventilation 1.0 as per EN717 chamber method-RAL UZ 102. If air ventilation was 0.5 then the limit values should be doubled for formaldehyde emission criterion).The loading factor shall be paint specific, i.e. 1.0 for wall paints, 0.12 for trim and cladding paints.

5.1.2.3 Criterion – Titanium dioxide production – CRITERION WITHDRAWN

<table>
<tr><th>Core criteria</th><th>Comprehensive criteria</th></tr>
<tr><td colspan="2">AWARD CRITERIA</td></tr>
<tr><td></td><td>If the product contains more than 3.0% w/w of titanium dioxide then points shall be awarded in proportion to the reduction in energy used in its production and the recovery of co-products compared to the EU IPPC Reference document on Best Available Techniques' recommendations (see Table 43):

Table 43 Titanium dioxide energy and co-product requirements
<table>
<tr><th>Process</th><th>EU BREF BAT energy benchmark</th><th>Recovery and sale of co-products</th></tr>
<tr><td>Chloride</td><td>25 GJ/tonnes of TiO_2</td><td>- Iron from ore refining (if synthetic ore is used).
- Ferrous chloride from pigment production.</td></tr>
</table>
</td></tr>
</table>

129 EUROFINS, *French Regulations on VOC emissions from construction products*, available online at: http://www.eurofins.com/voc-france.aspx.

130EN 16402 - Paints and varnishes - Assessment of emissions of substances from coatings into indoor air - Sampling, conditioning and testing.

Sulphate	41 GJ/tonnes of TiO_2	- Iron from ore refining (if synthetic ore is used). - Iron sulphate (copperas) from feedstock processing	

Verification:
The tenderer shall submit supporting documentation showing compliance by the titanium dioxide producer for the raw material used in the paint product, to include 12 months data indicating the respective energy performance.

Rationale

Titanium Dioxide (TiO_2) is the most important pigment in the paint industry. It can be produced using two chemical processes: the sulphate or the chloride process. The chloride process produces TiO_2through a reaction of titanium ores with chlorine gas. The sulphate process produces TiO_2 by reacting titanium ores with sulphuric acid. 70% of the European production is from the sulphate process and 30% from the chloride process. Waste arising from its production cover solid waste, strong acid waste, weak acid waste, neutralised waste, treatment waste and dust.[131]

Existing Community legislation on waste from TiO_2 industry aims to prevent and progressively reduce pollution caused by waste from TiO_2 industry with a view to eliminate such pollution. It also seeks to harmonise laws on waste from TiO_2 industry in order to avoid distortion of competition within the internal market. Three directives were addressing disposal (Council Directive 78/176/EEC[132]), monitoring and surveillance (Council Directive 82/883/EEC[133]) and programs for the reduction of pollution (Council Directive 92/112/EEC[134]) from TiO_2production. At present these have been replaced by the Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control).[135]

As shown in the environmental assessment section (chapter 4.1) reduction in the use of pigment in paints, and particularly TiO_2, is desired as it is a significant contributor to the paint's environmental impact. The EU Ecolabel includes a criterion that addresses waste and emissions from both the chloride and sulphate production processes. Having reviewed further the LCA evidence base for the main impacts associated with TiO_2 it was considered meaningful to explore the criteria which instead focuses on energy use and recovery and use of co-products. This is because one of the main environmental impacts related to the energy use in the finishing step in the TiO_2 production process but there is a trade-off in relation to the type of the ore use in the two main production processes. Based on the evidence in the BREF Reference Document on Best Available Techniques[136]this trade-off could be mitigated by the recovery and sale of co-products from preparation of the ore.

131 For more detail see DH Environment webpage: http://ec.europa.eu/environment/waste/titanium.htm.
132 Council Directive 78/176/EEC of 20 February 1978 on waste from the titanium dioxide industry, OJ L 054, 25.02.1978, p.19.
133 Council Directive 82/883/EEC of 3 December 1982 on procedures for the surveillance and monitoring of environments concerned by waste from the titanium dioxide industry, OJ L 378, 31.12.1982, p. 1.
134 Council Directive 92/112/EEC of 15 December 1992 on procedures for harmonizing the programmes for the reduction and eventual elimination of pollution caused by waste from the titanium dioxide industry, OJ L 409, 31.12.1992, p. 11.
135 Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast), L 334, 17.12.2010, p. 17.
136Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals - Solids and Others industry, August 2007, available online at: http://eippcb.jrc.ec.europa.eu/reference/BREF/lvic-s_bref_0907.pdf, accessed April 2014.

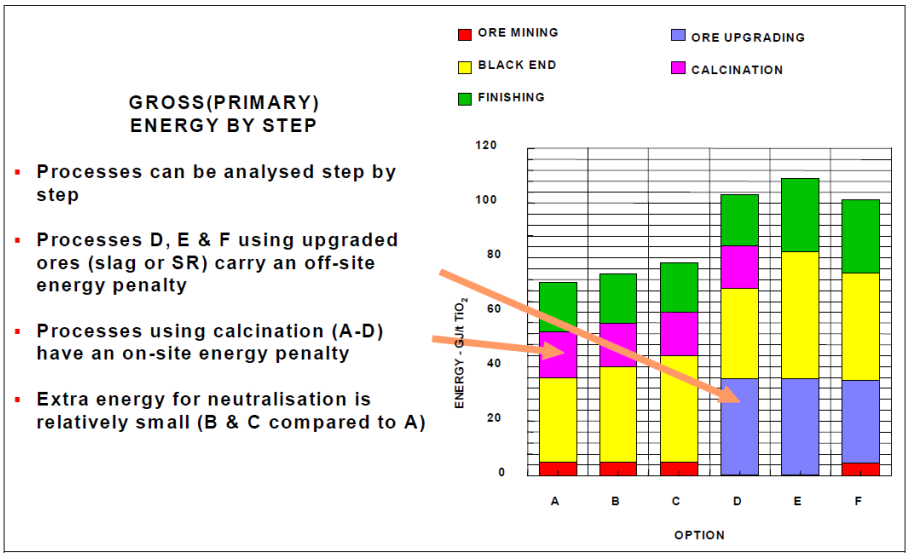

Figure 11: Comparison of primary energy used for different titanium dioxide production options

Source: Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals - Solids and Others industry, 2007

Therefore, an **award comprehensive criterion** was proposed initially to be set in the GPP criteria set. It was required that for products containing more than 3.0% of TiO_2 points shall be awarded in proportion to the reduction in energy used in its production and the recovery of co-products compared to the 'EU IPPC Reference document on Best Available Techniques' recommendations.

Regarding **verification** to proove the compliance with the requirement the tenderer shall submit supporting documentation by the titanium dioxide producer for the raw material used in the paint product, to include 12 months data indicating the respective energy performance.

Table 44: Titanium dioxide energy and co-product requirements

Process	EU BREF BAT energy benchmark	Recovery and sale of co-products
Chloride	25 GJ/tonnes of TiO_2	- Iron from ore refining (if synthetic ore is used). - Ferrous chloride from pigment production.
Sulphate	41 GJ/tonnes of TiO_2	- Iron from ore refining (if synthetic ore is used). - Iron sulphate (copperas) from feedstock processing

Regarding **verification** to prove the compliance with the requirement the tenderer shall be asked to submit supporting documentation by the titanium dioxide producer for the raw material used in the paint product, to include 12 months data indicating the respective energy performance.

Follow-up from the stakeholders' consultation

Industrial association provided the feedback on the criterion, which, although recognised meaningfulness of addressing this environmental aspect did not agree with the first criteria formulation stating among others that "*BREF mentions that there is no single 'best' option for TiO_2 production and that the long term availability of a local market for low value co-products was an*

important factor. (...) The amount of energy used by the TiO_2 producer depends on the feedstock purchased and the waste treatment option chosen. If a higher grade feedstock is used then the energy requirement for the TiO_2 producer is less because the energy has already been used by the feedstock supplier to upgrade the feedstock. The overall energy usage is similar but the quantity of energy used by the TiO_2 supplier to the paint industry varies significantly but with no linear relationship to the overall environmental impact of the product" (...) An energy criteria would penalise sites using lower grade feedstock and acid recycling".

A second proposal was prepared and consulted with industry, which differentiated further between energy consumption requirements for sulphate process depending whether sulphuric acid neutralisation or sulphuric acid re-concentration was conducted (see Table 46).

Table 45: Overall energy efficiency in titanium dioxide production

Process	EU BREF BAT energy benchmark
Chloride	25 GJ/t of TiO_2 pigment
Sulphate	29 GJ/t of TiO_2 pigment in the process with sulphuric acid neutralisation 41 GJ/t of TiO2 pigment in the process with sulphuric acid re-concentration

This proposal also did not find support from the industry side. The following feedback was provided: "*The problem is there is no proportional link to environmental performance because so much of the life cycle depends on the energy consumed in producing the feedstock (titaniferous ores) that the TiO2 producers purchase. Indeed this is evident from the wide range of figures reported in the BREF. We have no control of the energy consumed in mining, extraction and concentration activities of our suppliers and nor can we choose the type of feedstock we purchase (slag, ilmenite, rutile) beyond the specific design capabilities of the individual production plants. Limited choice within a specific ore type might be possible but energy data may be limited and since this is by far the largest variable cost for production, producers will typically be tied into multi-year purchase contracts so in practice we have no control.*

Regarding recovery and re-use of co-products we would obviously support initiatives that encourage the recovery and use of co-products (which provide benefits in potential avoidance of waste, material conversation and possible energy benefits if the overall use profile is considered) but each plant is so individual in terms of what co-products can be produced (process type, feedstock, treatment technology, availability of local markets) that setting requirements on recovery and sale could indeed create barriers".

In the light of the above feedback in this criteria proposal the requirement is withdrawn. Nevertheless, for the future revision further investigation of feasibility of setting a criterion on titanium dioxide energy consumption and co-product generation/use should be conducted.

5.1.3 CONTRACT PERFORMANCE CLAUSES FOR PAINTS AND VARNISHES

Contract performance clauses are used to lay down the framework how a contract shall be carried out. For instance, in contract performance clauses the authority may specify the way the goods are to be supplied, how the service is performed, how the disposal of used products or packaging shall be managed or can specify training of contractor staff required. In the contract clauses

environmental considerations at the performance stage can be addressed.[137] In this section of the criteria requirements on technical advice and site inspections are included.

5.1.3.1 Criterion 1 Technical advice and site inspections

Core criteria	Comprehensive criteria
CONTRACT PERFORMANCE CLAUSES	
1 Technical advice and site inspections *(Same for core and comprehensive criteria)* The tenderer shall provide technical advice and site works instructions to the Contracting Authority or their contractors. This shall include the following: • Method statements and guidance on substrate preparation; • Method statements and guidance on paint preparation, including estimates for application per m^2; • Optimal conditions for storage and application of the product; • Risk mitigation measures to minimise environmental pollution; • Advice on appropriate disposal of unused paint. Technical advice shall also be made available, upon request, to the site-operatives of the Contracting Authority or their contractors either in the form of on-site visits (in a number and scope to be specified by the contracting authority at tendering stage) or a technical hotline (in a language specified by the contracting authority). The tenderer shall provide documentation which contains the listed information. Written feedback from the operatives applying the paint shall confirm satisfactory provision of technical advice and site support.	

Rationale

It is considered important that the GPP criteria for the purchase of paints with a reduced environmental impact address technical advice and on-site inspections aspects (in both **core and comprehensive** criteria sets). These will be supportive to ensure appropriate storage and application of the product, which in consequence assure that, among others, the product is not wasted and its application fulfils high quality standards. Furthermore, in order to prevent environmental pollution, the tenderer shall advise the contractor how to mitigate potential risks through indicating risk mitigation measures.

An example of a site-work advice and instructions prepared by Akzo Nobel was reviewed.[138] This example highlighted what information the paint suppliers may provide to the contractor or the site services they may provide. Based on this the following areas were identified:

- Method statements and guidance on substrate preparation and on paint preparation,
- Ambient conditions for storage and application of the product,

137 Buying green! A handbook on environmental public procurement, available online at: http://ec.europa.eu/environment/gpp/pdf/buying_green_handbook_en.pdf, accessed May 2014.
138 ICI Paints, AkzoNobel, Site Work Instructions v5, 2012, available online at: http://dulux.trade-decorating.co.uk/web/pdf/guides/site_work_instructions.pdf.

- Risk mitigation measures to minimise environmental pollution,
- Site-visits or a technical advice by technician to support the work.

It is therefore proposed that the **core and comprehensive criteria** consist of a number of areas of technical advice together with the availability of site-visits by technicians or a technical hotline from the paint manufacturer.

5.2 PAINTING WORK CONTRACTS

In the section of the report aspects and requirements related to painting work contracts are presented. Initially it was intended to keep the GPP criteria for painting and road marking application road contracts together in one set. Nevertheless, after extensive consultation with stakeholders from the road marking sector it was agreed that due to differences in application, product characteristics, its function and safety reasons (that last for road markings) the criteria for painting services and road marking application should be kept separate.

Painting work contracts can include one-off works contracts; call down contracts from a framework as well as performance based painting contracts. These contracts provide an opportunity to focus not just on the product but on how efficiently it is used and the overall durability of the painted surfaces. This is in line with the background technical analysis which highlighted the importance of extending the life-span of the product.

A major example for paints and varnishes would be the cyclical painting of municipal housing and buildings, inclusive of window frames, facades and metal balustrades, as well as interior decoration and street furniture (lamps, benches, etc.).

5.2.1 SELECTION CRITERIA

5.2.1.1 Criterion 1 Competencies of the tenderer

Core criteria	Comprehensive criteria
SELECTION CRITERIA	
1. Competencies of the tenderer *(Same for core and comprehensive criteria)* The tenderer shall demonstrate professional competencies in the following areas, as relevant to the nature of the contract being let (*choose as relevant for the contract*): • Method statements for the efficient use of paint on-site, including the preparation of estimates and the use of specialist equipment; • Method statements for the preparation of substrates and paint formulations prior to application. This shall include, as appropriate, safety procedures for the removal of existing films and coatings, and the handling of new paints and varnishes during their application; • The application of environmentally improved products, including those with reduced VOC content; • The application of durable and high specification finishes, with reference to relevant EN standards or their equivalent; • Policies and supporting management systems to minimise paint waste, maximise the reuse or recycling of unused paint and to ensure their safe disposal and safe disposal of other chemicals such as paint stripping agents. **Verification**: The tenderer shall provide evidence in the form of information and references related to relevant contracts in the previous 5 years in which the above elements have been carried out.	

Rationale

Selection criteria are related to the capacity of bidders to perform the contract.[139] In order to be selected for the painting service the tenderer needs to demonstrate a range of professional competencies in the areas relevant to the nature of the contract. For the purpose of these GPP criteria it is considered that the most important competencies encompass:

- Method statements for the efficient use of paint on-site, including the preparation of estimates and the use of specialist equipment;
- Method statements for the preparation of substrates and paint formulations prior to application. This shall include, as appropriate, safety procedures for the removal of existing films and coatings, and the handling of new paints and varnishes during their application;
- The application of environmentally improved products, including those with reduced VOC content;
- The application of durable and high specification finishes, with reference to relevant EN standards or their equivalent;
- Policies and supporting management systems to minimise paint waste, maximise the re-use or recycling of residual paint and to ensure safe disposal of waste paint and other chemicals such as paint stripping agents.

The same requirements apply to both, **core and comprehensive criteria sets**.

Regarding **verification** of compliance the tenderer shall provide supporting documentation including method statements, product specifications used on previous contracts and policies relating to residual and waste paint handling. In addition, it is asked that the performance data from previous work contracts shall be provided where available.

5.2.2 TECHNICAL SPECIFICATIONS FOR PAINTING WORK CONTRACTS

5.2.2.1 Criterion 1 Use of paints meeting the EU GPP criteria

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
1. Use of paints meeting the EU GPP criteria *(Same for core and comprehensive criteria)* Painting work contracts shall be performed using paint products that comply with the EU Green Public Procurement requirements as specified in Technical Specifications for core criteria of EU GPP Section 4.1 Paints and Varnishes. **Verification**: The tenderer shall provide supporting documentation that the products to be used meet the criteria specified above.	

139 European Commission 'Buying Green Handbook', 2011, available at: http://ec.europa.eu/environment/gpp/buying_handbook_en.htm.

This criterion was introduced in order to ensure that the criteria for environmentally preferable products and for work contracts are used simultaneously by the procurers who intend to purchase "a service and a product in one tender".

5.2.2.2 Criterion 2 Management of waste and unused paint

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
2. Management of waste and unused paint *(Same for core and comprehensive criteria)* The tenderer shall submit a waste management plan for paint leftover from the preparation of the substrate and application. The plan shall include: • Where paint removal/demarking needs to be conducted, an assessment for the potential hazardous content of paint that has been stripped from substrates and, if a risk is identified, a method statement for mitigating the risk by safe handling and disposal. • A method statement shall be provided for on-site practices in the cleaning of painting equipment and the storage of waste and unused paint for safe disposal as hazardous waste. • Measures to minimise waste and unused paint. **Verification:** The tenderer shall provide a documented waste management plan which shall include method statements for safe paint stripping, equipment cleaning and waste and unused paint handling and disposal, as well as the measures applied to minimise waste and unused paint. *Monitoring of paint waste shall then take place through a contract performance clause.*	

Rationale

As indicated in section 4.1 on LCA of paints, unused paint is one of the environmental issues of concern. It can be considered hazardous waste and its amount should be kept as low as possible.

In general, there lacks data about the shares of paint products left unused after completing the application process and wasted. The study conducted by WRAP[140] highlighted the problem of unused paint in the UK. In the domestic sphere, around 25% of all paint goes unused, whereas in trade sector it is 1.5%. Monitoring of the amount of paint waste is addressed in the framework of contract clauses.

Further, it is considered important that a tenderer has or establishes a waste management plan for waste paint arising from the preparation of the substrate and application of new paint. This plan shall ensure safe handling, storage and disposal of the paint. In addition, indications regarding appropriate practices for cleaning of paint equipment are of importance. The plan proposed for **core and comprehensive criteria** shall include:

– A assessment for the potential hazardous content of paint that has been stripped from substrates and a method statement for its safe handling and disposal. This is being highlighted also by the US EPA as a potential issue where, for example, older paints may

140Lee P., Willis P, WRAP, Paint and woodcare products – distribution and delivery – A review of alternative supply chain approaches within UK paint and woodcare markets, Final Report, 2011.

contain metals like lead and cadmium require stripping. It may also be the case fthat pigment such as lead chromate (now a substance of very high concern) may have been used.

- A method statement for on-site practices in the cleaning of painting equipment and the storage of residual paint for safe disposal as hazardous waste. The on-site system for washing the water-based paints from the equipment in order to prevent the residues from paint washing entering the drainage system could be an effective example of one of such practices.
- A description of measures to minimise waste and unused paint.

Regarding **verification** of compliance with the criterion the tenderer shall provide a documented waste management plan including method statements for safe paint stripping, equipment cleaning and residual paint handling and disposal. Monitoring of paint waste arising shall be addressed as a contract clause.

5.2.3 AWARD CRITERIA FOR PAINTING WORK CONTRACTS

5.2.3.1 Criterion 1 Performance based painting contracts

Core criteria	Comprehensive criteria
AWARD CRITERIA	
	1. Performance based painting contracts *(Where long-term performance based painting and maintenance contracts are tendered)* Points shall be awarded according to the estimated volume of paint used to maintain the quality of the painted surface during the life-time of the contract. **Verification:** The tenderer shall provide a document setting out the estimated quantities of paint required during the contracted program, including assumptions made about the required number of repaints over the life-time of the contract.

Rationale

In addition to the above criterion, a second **comprehensive award criterion** is proposed for performance based painting contracts which cover also repainting services. It is understood from examples from public sector housing maintenance contracts in the UK that overall costs can be reduced over the life-span of the contract by selecting more durable products and by more frequent preventative works to prevent deterioration of a painted surface or material. Where a contract is over longer period of time, 5 years of more, then there will be an inherent incentive for the contractor to choose paint products that are more durable.

Therefore it is proposed that points shall be awarded according to the potential for savings in paint use for planned, cyclical repainting by providing supplementary maintenance and remedial services for painted surfaces. Such performance based contracts could cover maintenance services (on an agreed time-basis), cleaning of dirty surfaces and repairing damaged ones.

Regarding **verification** of compliance with the requirements the tenderer shall provide a document setting out the estimated quantities of paint required during the contracted program as well as the potential for savings on paint.

5.2.3.2 Criterion 2 Reuse and/or recycling of waste and unused paint

Core criteria	Comprehensive criteria
AWARD CRITERIA	
	2. Reuse and/or recycling of waste and unused paint Points shall be awarded reflecting a commitment to reuse or recycle waste and unused paint. The tenderer shall submit a management plan setting out the arrangements made to ensure that waste and unused paint arising from works will be: • Reused by the contractor, and/or • Reused externally; and/or • Recycled. Reuse or recycling routes could include reuse projects or the manufacturing of new paint using waste and unused product as a base. A monitoring system will be used to account for waste and unused paint. **Verification:** The tenderer shall provide a documented management plan which shall include a description of the arrangements made to ensure that waste and unused pain will be reused by the contractor and/or other external entity and/or recycled.

Rationale

A **comprehensive award criterion** is proposed for the area of management of residual paint. As shown in the environmental evaluation section the end of life of paint is a problematic area. Reduction of the amount of paint which is disposed shall be strived, as it contributes to decrease of the overall environmental impact. Re-use and recycling of unused paints are sustainable though still not widely used practices which could be used to achieve this goal. Therefore, in order to promote tenderers who are committed to re-use or recycle of residual product it is proposed to set a

comprehensive award criterion on paint re-use and recycling. Re-use or recycling routes could include re-use projects or the manufacturing of new product using residual paint as a base. The tenderer shall submit a management plan setting out how residual paint arising from works will be:

- Re-used on the same or other contracts, and/or
- Arrangements to ensure it is re-used or recycled externally.

Regarding **verification** of compliance with the requirements of this criterion the tenderer shall provide a documented management plan which shall include method statements for handling and storage of residual paint for re-use by the contractor, as well as arrangements for re-use or recycling of paint by third parties. The monitoring system shall record the quantities of waste paint arisings and their subsequent use.

5.2.4 CONTRACT PERFORMANCE CLAUSES FOR PAINTS WORK CONTRACTS

5.2.4.1 Criterion 1 Management of paint handling

Core criteria	Comprehensive criteria
CONTRACT PERFORMANCE CLAUSES	
1. Management of paint handling *(Same for core and comprehensive criteria)* The contractor shall provide records of (*for performance based contracts*): • The quantity of paint purchased; • The actual paint quantities used in fulfilling the contract specifications. The contractor shall also provide records for waste and unused paint, including tracking where it has been: • Reused by the contractor; • Reused externally; • Recycled; • Safely disposed of. The contractor shall also provide records – in case old paint layer needed to be removed from the substrate that it has been: • Handled safely; • Disposed of safely for treatment as hazardous waste.	

Rationale

Contract performance clauses are used by public procurers to specify how a contract is to be carried out. They are related to performance of the contract, i.e. the tasks which are necessary for the production and the provision of the goods, services or works purchased. The compliance with the requirements specified in the contractual clauses is monitored along the period of carrying out of the contract.[141] For the GPP criteria set for the paints work contracts several issues are considered as of high relevance to the performance of the contract, taking into account the previously

141 European Commission 'Buying Green Handbook', 2011, available at: http://ec.europa.eu/environment/gpp/buying_handbook_en.htm.

mentioned aspects of highest relevance for the environmental performance of the service to be provided. Among them the most important include: the quantity of product purchased by the contractor to fulfil the work contract, the estimates regarding the need for repainting and the amount of actual product used by the contractor and the treatment of the paint that was removed from the substrate before the painting service was conducted. Additionally, it is considered essential that the contractor provides records on the residual paint amount and, when applicable, on the waste management practice applied to it; i.e. whether (and what share of it) was:

- Re-used by the contractor or externally,
- Recycled,
- Safely disposed of.

Further, in case the former old paint is removed from the substrate, proper handling and channelling it to the respective stream of hazardous waste is required.

The contractor shall provide reports on the records on the residual paint amount and, when applicable, on the waste management practice and the treatment of removed old paint at agreed intervals along the contract duration.

5.3 ROAD MARKINGS

The key environmental impacts associated with road markings are related to their use phase rather than to their production. As presented in the LCA review section (see chapter 4.2), durability of the road markings system under traffic wear is most decisive for the overall impact on the environment. In general, solvent based paints have a higher environmental impact than water based paints or thermo spray plastics or reactive 2-component cold spray plastics, while binder, glass beads and TiO_2 manufacture have an important environmental impact in the production stage. Additives have a wide range of health and environmental implications. Among the main substance related concerns are:

- Volatile Organic Components,
- Heavy metals: Pb, As, Sb (e.g. in glass beads),
- Pigments: Pb-chromates,
- Chlorinated or phtalate based plasticizers.[142]

Follow-up along the stakeholder's consultation

Environmental criteria in existing procurement practices

Along the consultation process procurers from different MS were contacted in order to better understand the way the procurement of road markings is conducted and the environmental aspects addressed in the existing tenders. An analysis of several calls, provided kindly by the procurers, was performed. In general, it can be said that only in very few MS environmental criteria are added into calls for tenders[143].

For instance in the city of Vienna only solvent-free cold plastic road markings are used. Additionally, the following environmental requirements must be met:

- content of lead chromate shall not exceed 0.25%,
- content of xylene shall be lower than 0,005%,
- materials should be nearly free of benzene, toluene and organochloride compounds.

A Norwegian procurer provided information that road marking materials they use shall not contain:

- heavy metals,
- carcinogenic substances or other compounds that will make the material classifiable as “Very toxic” or “Toxic”,
- above 2% by weight of VOC (Volatile Organic Compounds).

For glass beads that are to be used in road marking materials or for drop-on, any arsenic content shall not exceed 200 mg/kg.

The procurer indicated that their best environmental contributions are their strategies for road marking, namely:

- they analysed during six years annual cost and best practice at different roads and traffic intervals, to choose the right method water-based paint/spray/extruded thermoplastic,
- they decided that longitudinal road marking shall be laid in a milled strip in the asphalt course (6 mm high). This prevents the road marking from wear of traffic and snow-clearing machines. In this case the lifetime of road marking has increased by 50 – 150 %.

142Nuyttens R., 3M Europe, Advanced Technology for Traffic Signs & Road Markings, 2008, available online at: http://www.irfnet.ch/files-upload/news-gallery/green_public_procurement/12.NUYTTENS_3M.pdf, accessed May 2014.

143 Personal communication with the procurers.

This kind of strategy would be of importance for countries with cold climate and heavy snowfalls during winter period.

Belgian authority informed that the only environmental requirement used in their tenders refers to using low-VOCs products is some communes.

No environmental criteria are added to tenders in Greece and Portugal, according to the information received.

Beside the public tenders, also existing labelling schemes were looked at:

NF Environment French Ecolabel for road markings[144]sets the following requirements:

- Substances classified as carcinogenic, mutagenic or toxic for reproduction, very toxic, toxic or subject to sentences R51, R52 or R53 shall be excluded.
- Preservatives used in the product composition may contain substances classified as dangerous for the environment, toxic or very toxic for human health within the limit of 0.1% of the total composition of the product.
- Arsenic-based compounds, cadmium, chromium VI, mercury or lead shall not be used. Ingredients may however contain impurities or traces of heavy metals from raw materials, within the regulatory limits according to Directive 67/548/EC and its amendments.
- The following glycol ethers (CAS number in brackets): EGME (109-86-4), EGEE (110-80-5) EGMEA (110- 49-6) EGEEA (111-15-9) EGDME (110-71-4) DEGEE (111-90-0) DEGDME (111-96-6) TEGME (112-35-6) TEGDME (112-49-6) and EGBE (111-76-2) shall not be used.
- The product shall be not labelled as explosive (E) oxidising (O) extremely flammable (F +), highly flammable (F), Flammable (R10), very toxic (T +), toxic (T), harmful (Xn), corrosive (C) irritant (Xi) and dangerous for the environment (N) according to Directive 67/548 / EEC and Directive 99/45 / EEC and their adaptations.
- There are requirements regarding total losses during manufacturing and product packaging, as well as the treatment of production waste.
- White pigment content shall not exceed:
  - 200 g/m^2 of dry film for painting,
  - 400 g/m^2 of dry film for a coating or a preformed type,
- Information on emissions from titanium dioxide production shall be provided.
- VOC content should be less than or equal to 80 g/kg (excluding water).
- Aromatic hydrocarbon content should be less than 0.5% by weight in the formulation.

Brazilian Ecolabel for roadmarking systems[145] includes the following requirements:

- Environmental criteria for the product cover performance characteristics (night time visibility, daytime visibility, coefficient of resistance, erosion).
- The following heavy metals or their compounds should not be used as ingredients of the product or pigment whether as a substance or as part of any preparation used:
  - Cadmium
  - Lead
  - Chromium VI
  - Mercury
  - Arsenic
  - Barium (excluding barium sulfate)
  - Selenium

144 For more information please see: NF Environnement – Produits de signalisation horizontale, available online at: http://www.ecolabels.fr/fr/recherche-avancee/categories-de-produits-ou-services-certifies/produits-a-usage-professionnel/nf-environnement-produits-de-signalisation-horizontale.

145 For more information please see Road Marking Systems – PE-167.0A, 2011, available online at: http://www.abnt.org.br/.

- Antimony

  It is accepted that ingredients may contain traces of these metals up to a maximum of 0.01% (w/w) from impurities of raw materials.
- Solvents containing halogenated or aromatic hydrocarbons in its formulation shall not be used.
- The content of VOCs in the final product shall be less than or equal to 150 g/kg according to ASTM D2369-10.
- There are also criteria for packaging, distribution, criteria applicable to the process.
- Program for optimization of energy and water consumption, including reduction goals as appropriate.
- Waste management program.

One of the issues raised by the procurers along the consultation process was related to the ***inclusion of conservation works*** into the criteria. For instance it could be prescribed that the durability must be certain amount of years and that at the end of this period a set maximum level of damage is allowed (in special cases additional minor maintenance is permitted). It was also proposed that the requirements could address more the terms of durability, visibility, etc.

The performance is defined through the following parameters: retro-reflexion (sometimes also under wet conditions), day luminance, roughness and colour. And these are also the main specifications which are controlled in reference to the performance of the road marking.

This is however not easy to set unique performance requirements, as it there are various aspects which needs to be taken into account while setting the requirements; for instance the location and type (is it a highway or a small village street), the climatic conditions (wet/dry), the traffic intensity and other. It is up to the procurer to specify the intended application. The GPP criteria shall promote use of more environmentally friendly products or techniques available on the market. It should allow comparison of offers, and assigning most points to the best offers in the environmental evaluation part of the tendering process.

Road markings are a safety product, thus their performance cannot be compromised due to their formulation. There are however various trade-offs between different aspects. Let's take for instance the intention to minimise TiO_2 content and expanding the durability of the marking. This makes this criteria development a challenging task. Therefore, in the revised draft, several of the criteria have been proposed as award criteria. This will allow for granting point to these tenders which offer better environmental performance for specific (and specified by the procurer) application, without setting absolute requirements.

It is recognised that industry and regulators are still working on establishing a common framework for the evaluation of road markings at the European market (developments in the framework of CPD and CE marking and harmonisation of standards for performance testing). Beside this, industry is working on promoting minimum performance requirements for existing applied markings. All these developments shall be taken into account in the future revision of these criteria.

5.3.1 TECHNICAL SPECIFICATIONS FOR ROAD MARKINGS

5.3.1.1 Criterion 1 Road marking formulation

5.3.1.1.1 Content of Volatile Organic Compounds (VOC's)

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
1.1 Content of Volatile Organic Compounds (VOCs) (i) The maximum content of VOCs shall not exceed a limit of 150 g/l. The content of VOCs shall be determined for the ready-to-use product and shall include any recommended additions prior to application. Solvents which have negligible contribution to smog formation (listed in Annex 4) may be excluded from VOC calculation. Exceptionally, when procurers determine that the road markings must be applied under external weather conditions which prevent the use of low VOC road markings (relative air humidity > 80%, air temperature < 5 ˚C or > 40 ˚C), the total content of VOC shall not exceed 395 g/l. (ii) The following compounds shall not be used: – Chlorinated solvents, such as methylene chloride or chloroalkanes, – Aromatic solvents, such as benzene, ethyl benzene, toluene, or xylene, – Ethylene-based glycol ethers or their acetates. **Verification:** The tenderer shall provide results of calculation based on the ingredients and raw materials or a test report according to ISO EN 11890-2, ASTMD 2369 (where reactive diluents are present) or equivalent supported by necessary calculations. In addition, a declaration that the specificaly excluded solvents are not used, shall be provided.	**1.1 Content of Volatile Organic Compounds (VOCs)** (i) The maximum content of VOCs shall not exceed a limit of 100 g/l. (ii) The following compounds shall not be used: – Chlorinated solvents, such as methylene chloride or chloroalkanes; – Aromatic solvents, such as benzene, ethyl benzene, toluene, or xylene; – Ethylene-based glycol ethers or their acetates. **Verification:** The tenderer shall provide results of calculation based on the ingredients and raw materials or a test report according to ISO EN 11890-2, ASTMD 2369 (where reactive diluents are present) or equivalent supported by necessary calculations. In addition, a declaration that the specificaly excluded solvents are not used, shall be provided.

Rationale

As explained in the section 5.1.1.1.2 use of volatile organic compounds in paint products was identified as an important environmental aspect, hot spot in the LCA of paints. Many VOCs have short- and long-term adverse health and environmental effects.

In general the four different road marking systems used show different characteristics of VOC emissions. Table 46 below describes in general terms solvent content and related VOC emissions of the various road markings types:

Table 46: Solvent content and related VOC emissions of road marking systems

Paint Systems		Cold plastic Systems	Thermoplastic Systems
solvent-based	**water-based**		
medium to high solvent content	low solvent content	medium solvent content (reacting during polymerisation)	no solvent content
medium to high VOC emission	low VOC emission	low VOC emissions	no VOC emission

Source: Ökopol, 2009[146]

According to the information collected in the framework of a study completed for the European Commission in 2009 by the Ökopol consultancy[146] on the assessment and review of Directive 2004/42/EC[147] VOC reduction potential was estimated, among others for road markings. It was recognised in the study that across Europe the main road marking systems vary. For instance in Sweden, the most commonly used systems are thermoplastics and to lower extent dispersion paints. In Germany mainly cold plastics and thermoplastics are used, especially on federal roads. At the community level – road marking paints are used more frequently. In France and some Eastern European countries like Poland, Hungary, Slovenia and Czech Republic paint systems are mainly used. In Spain – cold plastic and thermoplastics, similarly in Italy and Portugal. In Austria solvent-based paints are predominantly used.

In 2010 additional study was conducted by Ökopol and IER University of Stuttgart[148] specifically on road markings to evaluate the option of limiting the VOC solvent content in road markings to 60 g/l. The authors compared the existing national VOC limits in MS for public procurement limitation on VOC content:

- In Germany and Austria for solvent-based paints the max VOC content in public tenders was 25% (weight),
- In Netherlands – 28%,
- In Sweden and Finland – the VOC content was restricted to 2%.

It should be added that, taking into account the product densities a limit of 25% (weight) corresponds to 375-575 g/l, 10% - to 150-230 g/l and 2% - to 40-100 g/l.

Outside Europe VOC limit values were found for Canada and USA. In USA, the threshold of 150 g/l or even 100 g/l for some regions was established. For Canada – 150 g/l for the period between May and September and 450 g/l for the rest of the year.[148]

In accordance with the estimations made for the review of the 2004/42/EC Directive if all solvent-based road markings are substituted by water-borne products, VOC emissions from road markings

146 Ökopol GmbH, Assessment and Review of Directive 2004/42/EC, Final Report, 2009, available online at: http://ec.europa.eu/environment/air/pollutants/pdf/paints_report.pdf, accessed May 2014.

147 Directive 2004/42/CE of the European Parliament and of the Council of 21 April 2004 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, OJ L 143, 30.4.2004, p. 87.

148 Ökopol and IER University of Stuttgart for Dow and Gaveco, Review of the Directive 2004/42/EC – Report on the potential scope extension of the directive covering road markings, 2011, available online at: http://www.geveko-markings.com/fileadmin/Brochures/VOC_Impact_assessment_of_road_markings_environmental_impact.pdf, accessed May 2014.

could be reduced by approximately 80% in comparison with the state-of-art of the analysed situation. According to the results obtained from the impact assessment in the second study, the potential to reduce VOC emissions from road markings in the EU 27 by the year 2020 amounts approximately 40 kilotons, assuming a mean content of VOC in road markings to be 30 g/l.

Indicative price levels (solvent-based set as 1) and expected life times of various road marking systems, as given in the Ökopol study, are presented in Table 47. They are included just to give orientation on the differences between the systems.

Table 47: Cost structure and expected life time of road marking systems

Road marking system	Cost index	Expected functional life time (years)
Solvent-based pain	1	1-2
Water-based paint	1.1-1.3	1-2
Thermoplastic	4.2-4.5	3-5
Cold plastic	4.3-4.6	3-5
Cold spray plastic*	2.1-2.4	2-3

*The costs include drop-on glass beads
Source: Ökopol and IER, 2011

According to the values provided in the study[148] in 2006 for EU 12 only 12% of the paint systems produced constituted water-based road marking paint systems. Currently, a mean content of VOC emission from solvent-based paint was approximately 400 g/l (about 25 weight-%).

Following the rationale regarding VOC emissions presented for paints (chapter 5.1.1.1.2) and the stakeholders' feedback received along the consultation process it is proposed to require that tenderers offer also road marking paints with reduced amount of VOCs in the formulation.

During the consultation process diverse feedback was received from stakeholders on the potential limit values for VOCs in road markings. One industrial stakeholder proposed to set the maximum VOC content in the product at the level used in point NF Environnement 331 criteria (i.e. the voluntary certification mark issued by AFNOR – the French certification body and the only national Ecolabel for road marking products in Europe). NF mark requires that VOC content in road markings must be less than or equal to 80 g/kg in the product (excluding water). This would equate to the use a water-based paint products or structural plastic systems.

However, further investigation suggest that there is still a demand for solvent-based paints but this can now be formulated with a lower VOC content. Evidence from a Brazilian standard [149] as well industries response to VOC content, restrictions by the US EPA [150] and Environment Canada [151] suggest that a threshold of 150 g/l may better reflect a low VOC solvent-based paint. It should be however taken into account that in the US and Canada the calculation of VOC content certain compounds are exempted due to their low potential to smog formation.[152] Pricing in the US suggests that this type of product can be obtained for the same price as conventional solvent-based paint.

For European countries where very high summer temperatures or very low winter temperatures are a constraint (i.e. in order to ensure that the product application and drying process proceeds properly the VOC content must be higher) the threshold of 395 g/l (which corresponds to the above mentioned 25% weight) was proposed.

149 ABNT, *Ecolabel for roadmarking systems*, February 2012 revision, Brazil.
150 Responsible Purchasing Network, *Green purchasing best practices: Traffic paint*, 30th September 2013, USA.
151 Environment Canada, *Performance of Waterborne, Low Temperature, Low VOC Traffic Paint*, May 2010.
152 See below in this section for more explanation.

This constraint was highlighted by a number of stakeholders who expressed their disapproval of strict limitations of VOC content in road markings. They explained that: *'especially important in countries of Mediterranean climate, where the solar radiation and the pavement temperature make necessary a high performance of these products so they can resist a reasonable period of time in good conditions. Water-borne coatings and thermoplastics (hot coating) show a thermoplastic behaviour: when the temperature increases will soften and increase its plasticity. In countries of Mediterranean climate, the high temperatures reached in summer make these products deteriorate much, especially its daytime visibility and duration. Therefore, using solvent-borne coatings and multi-component plastics (cold coating) is essential'.*

Further, they stated that: *'A general restriction of VOC content for all types of road marking paints it is not a reasonable approach because it is not feasible to substitute directly the high VOC types (solvent-borne) by the low VOC types (water-borne)'.*

They also pointed out that due to technological advancements two different types of solvent-based formulations exist: the first of them using solvents that result in the product being classified as harmful and eventually also as dangerous for the environment and another type, which are much less dangerous that do not make the product to be classified neither as harmful or dangerous for the environment. Therefore, the stakeholders propose a new approach linked to consideration of the nature of the solvents used in the formulations. They ask to set a different VOC limit value for those solvent-born paints formulated with solvents not classified as harmful or dangerous for the environment.

Recommendations from the US on purchasing of solvent-based road markings suggest the restriction on the following types of solvents, in addition to the limitation of the VOC content to 150 g/l required at the federal level:

- Chlorinated solvents (such as methylene chloride or chloroalkanes);
- Aromatic solvents (such as benzene, ethyl benzene, toluene, or xylene);
- Ethylene-based glycol ethers or their acetates.

Regarding **verification** in order to proove the compliance with the above requirements, the tenderer shall provide a test report according to ISO 11890-2[153] or equivalent.

Follow-up from stakeholders' consultation

In general, many stakeholders supported moving away from solvent-born paints. Although it was again mentioned that in some MS, where the climatic conditions are more extreme (e.g. in the south of Europe) solvent-based road markings are still commonly used. In those regions keeping the limit at 395 g/l, as proposed in the last draft, seemed feasible. Only one stakeholder proposed increasing the threshold to 410 g/l. It was said that it is, however, not possible to precisely define lower and upper temperature and this would need to be evaluated by the procuring authority.

Contradicting information was provided on this issue of climatic difference and possible conditions of use of water- and solvent-based products. On the one hand it was stated that water-based products cannot be applied in winter conditions due to "*their high sensitivity to humidity and low temperatures, and as they are more plastic*". In particular for concrete surface solvent-based products allow creating a strong bond in the temperatures experienced in countries like Denmark. Water-based paints would not give the bond strength required on a concrete surface. Also in countries of Mediterranean climate, due to "*the solar radiation and the pavement temperature it is necessary that a high performance products which can resist a reasonable period of time in good conditions*" are used. It was claimed that water-borne paints could not provide such good performance in these conditions.

153 ISO 11890-2 - Paints and varnishes -- Determination of volatile organic compound (VOC) content -- Part 2: Gas-chromatographic method.

Other stakeholders provided opposite information, stating that "*water-borne paints are successfully used for road-marking in Mediterranean countries including Spain and Italy*". Water-borne paints producer provided information that according to the results of their tests "*water-borne paints exhibit longer retention of night visibility and similar retention of day visibility when compared to solvent-borne acrylic traffic paint*". It was emphasized that the application temperatures recommended for solvent-borne paints, as well as thermoplastics and cold plastics is typically between 5 and 45 degrees, while the relative humidity below 75% or 80%. For water-borne paints the recommended temperature is between 10 and 45 degrees and relative humidity identical to the one of other kinds of road markings. The producer mentioned that there are specific technologies available to extend the window of application of water-borne paints in particular at high humidity.

The limit of 150 g/l (proposed for core criteria) can only be met by water-borne paints, cold plastic or thermoplastic. It is not technically achievable with existing solvent-borne paints. In the United States and Canada, where much lower limits are set, certain VOC which are considered to have negligible contribution to ground-level smog formation are excluded from the calculation. For instance acetone is excluded (for the complete list see below). The same approach was supported by some of the stakeholders and could be applied in the GPP criteria. It was quoted that if the exempt solvents were included in the calculation in the US the total VOC content would be around 400 g/l, however in this way use of environmentally harmful solvents can be limited, which is considered reasonable.

The US Federal Code of Regulations Title 40 Protection of Environment CFR 51.100(s) defines Volatile organic compounds and exempt compounds:

(s) "Volatile organic compounds (VOC)" means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions.

(1) This includes any such organic compound other than the following, which have been determined to have negligible photochemical reactivity:

- methane;
- ethane;
- methylene chloride (dichloromethane);
- 1,1,1-trichloroethane (methyl chloroform);
- 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113);
- trichlorofluoromethane (CFC-11);
- dichlorodifluoromethane (CFC-12);
- chlorodifluoromethane (HCFC-22);
- trifluoromethane (HFC-23);
- 1,2-dichloro 1,1,2,2-tetrafluoroethane (CFC-114);
- chloropentafluoroethane (CFC-115);
- 1,1,1-trifluoro 2,2-dichloroethane (HCFC-123);
- 1,1,1,2-tetrafluoroethane (HFC-134a);
- 1,1-dichloro 1-fluoroethane (HCFC-141b);
- 1-chloro 1,1-difluoroethane (HCFC-142b);
- 2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124);
- pentafluoroethane (HFC-125);
- 1,1,2,2-tetrafluoroethane (HFC-134);
- 1,1,1-trifluoroethane (HFC-143a);
- 1,1-difluoroethane (HFC-152a);
- parachlorobenzotrifluoride (PCBTF);
- cyclic,
- branched, or linear completely methylated siloxanes;
- acetone;

- perchloroethylene (tetrachloroethylene);
- 3,3-dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca);
- 1,3-dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb);
- 1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC 43-10mee);
- difluoromethane (HFC-32);
- ethylfluoride (HFC-161);
- 1,1,1,3,3,3-hexafluoropropane (HFC-236fa);
- 1,1,2,2,3-pentafluoropropane (HFC-245ca);
- 1,1,2,3,3-pentafluoropropane (HFC-245ea);
- 1,1,1,2,3-pentafluoropropane (HFC-245eb);
- 1,1,1,3,3-pentafluoropropane (HFC-245fa);
- 1,1,1,2,3,3-hexafluoropropane (HFC-236ea);
- 1,1,1,3,3-pentafluorobutane (HFC-365mfc);
- chlorofluoromethane (HCFC-31);
- 1 chloro-1-fluoroethane (HCFC-151a);
- 1,2-dichloro-1,1,2-trifluoroethane (HCFC-123a);
- 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy-butane ($C_4F_9OCH_3$ or HFE-7100);
- 2-(difluoromethoxymethyl)-1,1,1,2,3,3,3-heptafluoropropane ($(CF_3)_2CFCF_2OCH_3$);
- 1-ethoxy-1,1,2,2,3,3,4,4,4-nonafluorobutane ($C_4F_9OC_2H_5$ or HFE-7200);
- 2-(ethoxydifluoromethyl)-1,1,1,2,3,3,3-heptafluoropropane ($(CF_3)_2CFCF_2OC_2H_5$);
- methyl acetate; 1,1,1,2,2,3,3-heptafluoro-3-methoxy-propane (n-C3F7OCH3, HFE-7000);
- 3-ethoxy- 1,1,1,2,3,4,4,5,5,6,6,6-dodecafluoro-2-(trifluoromethyl) hexane (HFE-7500);
- 1,1,1,2,3,3,3-heptafluoropropane (HFC 227ea);
- methyl formate (HCOOCH3);
- 1,1,1,2,2,3,4,5,5,5-decafluoro-3-methoxy-4-trifluoromethyl-pentane (HFE-7300);
- propylene carbonate;
- dimethyl carbonate;
- *trans*-1,3,3,3-tetrafluoropropene;
- HCF_2OCF_2H (HFE-134);
- $HCF_2OCF_2OCF_2H$ (HFE-236cal2);
- $HCF_2OCF_2CF_2OCF_2H$ (HFE-338pcc13);
- $HCF_2OCF_2OCF_2CF_2OCF_2H$ (H-Galden 1040x or H-Galden ZT 130 (or 150 or 180));
- *trans* 1-chloro-3,3,3-trifluoroprop-1-ene;
- 2,3,3,3-tetrafluoropropene;
- 2-amino-2-methyl-1-propanol;
- and perfluorocarbon compounds which fall into these classes:
    - Cyclic, branched, or linear, completely fluorinated alkanes;
    - Cyclic, branched, or linear, completely fluorinated ethers with no unsaturations;
    - Cyclic, branched, or linear, completely fluorinated tertiary amines with no unsaturations; and
    - Sulfur containing perfluorocarbons with no unsaturations and with sulfur bonds only to carbon and fluorine.

Solvents which are among the compounds listed above can be excluded from the calculation of the VOC of the road marking product in the current proposal.

In the current proposal, in order to accommodate the needs of MS or regions, when procurers determine that there are local specificities impeding the use of low VOC road markings, it is proposed that the VOC content shall not exceed 395 g/l.

Beside this requirement, a possibility to introduce additional restriction on chlorinated and aromatic solvents, as well as ethylene-based glycol ethers or their acetates found stakeholders' support. They are state-of-the-art in some European MS like Germany or Switzerland and this requirement is kept.

One stakeholder indicated that for thermoplastic products, which are melt processed at about 200°C with considerable evaporation, instead of VOC SVOC may need to be considered. In the area of SVOC not much experience exists so far. In the area of decorative paints and varnishes for instance the EU Ecolabel requires also SVOC testing or calculation. In the case of road markings it is proposed to take into consideration this issue in the future revision, when more information is available.

Additional consultation results

A few stakeholders supported the proposed limit in the **core criteria** of 150 g/l excluding solvents having low contribution to smog formation such as acetone (used in some solvent-borne traffic paints) from VOC calculation. In the follow-up workshop three additional substances were requested from the industry side to be added to the list: ethyl acetate, butyl acetate and methyl ethyl ketone. A justification to the first two mentioned was provided, motivated by the high dissolving rate it has for acrylic binders and the low viscosity it provides. Also in the revised definition of Volatile Organic Compounds by the US Environmental Protection Agency (EPA) exclusion of t-butyl acetate was added[154]. These two substances were added to the list contained in the Annex to the criteria

In order to incentivise moving away from solvent-borne paints to alternative products, it was decided that the **comprehensive criteria** is set at max 100 g/L VOC without excluding any solvent from VOC calculation. In addition, it was supported by parts of stakeholders to remove the climatic exceptions, as it is considered that sufficient alternative solutions are available and authorities considering themselves as more advances in environmental protection should seek substitution of solvent-borne products (taking into account that this is a criterion for GPP front-runners).

Furthermore, the following compounds shall not be used (in both – core and comprehensive sets):

- Chlorinated solvents, such as methylene chloride or chloroalkanes,
- Aromatic solvents, such as benzene, ethyl benzene, toluene, or xylene,
- Ethylene-based glycol ethers or their acetates.

In addition, as agreed in the last round of consultations, in the **core criteria** exceptionally, the total content of VOC shall not exceed 395 g/l in the situations when procurers determine that the application should be done in the conditions which prevent the use of low VOC road markings (> 80% relative air humidity, air temperature < 5 ˚C or above 40 ˚C.

Regarding VOC **verification** it was mentioned that for reactive systems testing shall be conducted according to EC 2004/42[155], which defines ASTM 2369 as the appropriate test method for VOC content measurement on reactive systems. The verification of the criterion gives the possibility to provide a calculation or a test results according to ISO 11890-2 or ASTM 2369, as appropriate.

154 See: http://www.arb.ca.gov/research/reactivity/exemption/tbac.pdf.

155 See Article 3 and Annex III of the 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.

5.3.1.1.2 Criterion 1.2 Product hazard labelling

<table>
<tr><th>Core criteria</th><th>Comprehensive criteria</th></tr>
<tr><td colspan="2">TECHNICAL SPECIFICATIONS</td></tr>
<tr><td>

1.2 Product hazard labelling

The final product shall not be classified as being acutely toxic, a specific target organ toxicant, carcinogenic, mutagenic or toxic for reproduction, hazardous to the environment, in accordance with Regulation (EC) No 1272/2008 (CLP Regulation), as indicated in Table 48.

Table 48 Final product classification

Acute toxicity	Acute Tox. 1 Acute Tox. 2 Acute Tox. 3
Specific target organ toxicity – repeated exposure Specific target organ toxicity – single exposure	STOT RE 1 or 2 STOT SE 1, 2 or 3
Carcinogenicity	Carc. 1A Carc. 1B Carc. 2
Germ cell mutagenicity	Muta. 1A Muta. 1B Muta. 2
Reproductive toxicity	Repr. 1A Repr. 1B Repr. 2
Hazardous to the aquatic environment	Aquatic Acute 1 Aquatic Chronic 1 or 2

Verification:
The tenderer shall provide appropriate documentation confirming that the products to be supplied are not classified with the listed hazards.
The documentation of the mixture classification shall be provided in accordance with the rules provided in Regulation (EC) No 1272/2008 (CLP Regulation) and/or Safety Data Sheets.

</td><td>

1.2 Product hazard labelling

The final product shall not be classified as being acutely toxic, a specific target organ toxicant, carcinogenic, mutagenic or toxic for reproduction, hazardous to the environment, in accordance with Regulation (EC) No 1272/2008 (CLP Regulation), as indicated in Table 49.

Table 49 Final product classification

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Specific target organ toxicity – repeated exposure Specific target organ toxicity – single exposure	STOT RE 1 or 2 STOT SE 1, 2 or 3
Carcinogenicity	Carc. 1A Carc. 1B Carc. 2
Germ cell mutagenicity	Muta. 1A Muta. 1B Muta. 2
Reproductive toxicity	Repr. 1A Repr. 1B Repr. 2
Hazardous to the aquatic environment	Aquatic Acute 1 Aquatic Chronic 1 or 2 Aquatic Chronic 3

Verification:
The tenderer shall provide appropriate documentation confirming that the products to be supplied are not classified with the listed hazards.
The documentation of the mixture classification shall be provided in accordance with the rules provided in Regulation (EC) No 1272/2008 (CLP Regulation) and/or Safety Data Sheets.

</td></tr>
</table>

Rationale

Due to the use conditions of road markings and various factors influencing their performance along the product life cycle (e.g. climatic conditions, aging processes) various undesired substances may be released from the road marking. These compounds can be then washed off during rainfall to the

surrounding environment. In this sense hazardous ingredients contained in road markings may contribute e.g. to environmental hazard for neighbouring land used for agricultural purposes.[156]

As mentioned in the rationale for the same criterion for paints (see section 1.1.1.1.1), similarly to road marking products the formulations are complex consisting of high number of various compounds. Depending on the type of a road marking the formulation differs. A typical specification for white marking system consists of minimum 18% (weight) of binder, 10% of rutile (TiO_2) and minimum 48 % of glass beads. In the case of yellow markings instead of rutile 4% of yellow pigment of lead chromate (with a minimum of 50 % of lead) could be used. A binder could be maleic modified rosin ester and other plasticisers.[157]

Glass beads are fixed into the road marking that is sprayed onto the road surface. They are dropped into the wet paint, are enveloped by the paint (up to above the halfway point of the bead). Glass beads made of clear soda lime glass are composed approximately as follows: 70-74% SiO_2, 12-15% Na_2O, 8-10% CaO, 3.5-4.5 % MgO, 0.3-0.8 % K_2O, 0.0-0.2% Al_2O_3 and 0.08-0.1% Fe_2O_3.[157] In glass beads obtained from recycled material additionally certain amounts of impurities can be found, among them some metals, which are undesired pollutants, hazardous for the environment and human health.

In order to set a preventive measure to ensure that environmental and human health hazards have been taken into account in the product formulation it is proposed to require in both **core and comprehensive criteria** sets that products cannot be classified as hazardous to human health or the environment (in accordance with Regulation (EC) No 1272/2008 of the European Parliament and of the Council (the 'CLP Regulation') or Council Directive 67/548/EC (the 'DSD Directive')); i.e. they cannot be classified or labelled as:

- Acutely toxic,
- A specific target organ toxicant,
- Carcinogenic, mutagenic or toxic for reproduction,
- Hazardous to the environment (H400, H410, H411).

Additionally, in the **comprehensive** set of criteria one additional requirement is set: the requirement regarding classification or labelling as hazardous for the environment is set stricter to cover not only the classification:

- H400 Very toxic to aquatic life,
- H410 Very toxic to aquatic life with long lasting effects,
- H411 Toxic to aquatic life with long lasting effects,

but also:

- H412 Harmful to aquatic life with long lasting effects.

Regarding **verification** of compliance with the criterion tenderers shall provide calculations verifying that the products to be supplied do not require classification or labelling with the listed hazards carried out in accordance with the rules provided in the CLP Regulation.

Follow-up from stakeholders' consultation

The final classification refers to the road marking product as provided for purchase. Following the request from the stakeholders, beside the calculation of the final classification also provision of

156 Pal S. K., Wallis S. G. and Arthur S., Assessment of heavy metals emission from traffic on road surfaces, Cent. Eur. J. Chem. 9(2), 2011, pp. 314-319.

157 Diagnostic tool for source apportionment of heavy metals around roads, Fry, C., Jarvis, K.E. and Parry, S.J., UK Environment Agency, 2008, available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291000/scho0508bocy-e-e.pdf, accessed May 2014.

material safety data sheets (where the information on the classification of the mixture is given in section 2.1) was included in the verification of the requirement.

Along the discussions, the restriction on skin and respiratory sensitizers was mentioned several times. Benzoyl peroxide (PBO) use as a hardener for cold plastic mix is classified as skin sensitizer class 1. It is added in concentration of max 2% to the final product applied on the road surface. During processing it is chemically converted so that the hazard does not apply to a cured road marking. Currently the cold plastic products are classified as skin sensitizers due to PBO use and keeping this restriction would ban in practice their use, as according to the information provided, currently there are no alternatives available. This hazard can be avoided during application by use of protective cloths by the personnel applying the material. Material safety data sheets provide information on safety measures which should be undertaken in the application process. Due to environmental advantages linked to long durability of cold plastic materials and taking into account the current state of art, the restriction on sensitizers are removed from the current criteria set but should be re-evaluated in the case of revision, whether there was a technological progress and non-classified ingredients can be used for this material type.

5.3.1.1.3 Criterion 1.3 Hazardous ingredients

<table>
<tr><th>Core criteria</th><th>Comprehensive criteria</th></tr>
<tr><td colspan="2">TECHNICAL SPECIFICATIONS</td></tr>
<tr><td>1.3 Hazardous ingredients

The product shall be compliant with the restrictions presented in Table 50, where substances can be required to meet given characteristics or restricted on their concentration.

Table 50 Road markings hazardous ingredient requirements
<table>
<tr><th>Ingredient</th><th>Restriction or upper concentration limit</th></tr>
<tr><td>Dry film preservatives:</td><td>Preservatives shall be non bio-accumulative[1]</td></tr>
<tr><td>Phthalates:
Phthalates[158] identified as substances of very high concern and listed in the candidate list of the REACH Regulation[159] shall not be present in any paint or varnish preparations or formulations thereof.</td><td>0.1% w/w</td></tr>
</table></td><td>1.3 Hazardous ingredients

The product shall be compliant with the restrictions presented in Table 51, where substances can be required to meet given characteristics or restricted on their concentration.

Table 51 Road markings hazardous ingredient requirements
<table>
<tr><th>Ingredient</th><th>Restriction or upper concentration limit</th></tr>
<tr><td>Dry film preservatives:</td><td>Preservatives shall be non bio-accumulative[1]</td></tr>
<tr><td>Phthalates:
Phthalates[158] identified as substances of very high concern and listed in the candidate list of the REACH Regulation[159] shall not be present in any paint or varnish preparations or formulations thereof.</td><td>0.1% w/w</td></tr>
</table></td></tr>
</table>

158 To meet this requirement, tenderers and/or their suppliers will need to screen the REACH Candidate List for phthalates. Although phthalates may be easy to identify as an ingredient because their function is generally as a plasticiser, not all phthalates that appear on the Candidate List are readily identifiable. It may therefore be useful to provide tenderers with a chemical definition. For this purpose they are defined as "a group of chemical compounds whose structural basis is an ester of phthalic acid (1,2-benzene dicarboxylic acid)".
159 ECHA, Candidate List of substances of very high concern for Authorisation, https://echa.europa.eu/candidate-list-table

Metals: Cadmium, lead, chromium VI, mercury, arsenic, selenium	0.01% w/w per metal or metallic complex/salt, as appropriate

[1] An ingredient is considered bio-accumulative when Log Kow ≤ 3.2 or bio-concentration factor (BCF) ≤ 100.

Verification:

The tenderer shall provide appropriate documentation confirming compliance with the criterion, namely:

- for preservatives: Safety Data Sheets for the product mixture.
- additionally for preservatives: a test report using OECD 305 Test Guideline can be used as an alternative to the Safety Data Sheet for the sole purpose of confirming that the preservatives used are non-bioaccumulative.
- for phthalates: Safety Data Sheets for the product mixture and/or a REACH Article 33(1)[160] declaration that is valid for the products to be supplied.
- for metals: a test report based on the ISO 3856 series or equivalent.

Metals: Cadmium, lead, chromium VI, mercury, arsenic, selenium	0.01% w/w per metal or metallic complex/salt, as appropriate

[1] An ingredient is considered bio-accumulative when Log Kow ≤ 3.2 or bio-concentration factor (BCF) ≤ 100.

Verification:

The tenderer shall provide appropriate documentation confirming compliance with the criterion, namely:

- for preservatives: Safety Data Sheets for the product mixture.
- additionally for preservatives: a test report using OECD 305 Test Guideline can be used as an alternative to the Safety Data Sheet for the sole purpose of confirming that the preservatives used are non-bioaccumulative.
- for phthalates: Safety Data Sheets for the product mixture and/or a REACH Article 33(1)[163] declaration that is valid for the products to be supplied.
- for metals: a test report based on the ISO 3856 series or equivalent.

Rationale

As presented in the rationale for respective criterion established for paint products (see section 5.1.1.1.4) paint and roadmarking products contain a wide range of various compounds, many of which have hazardous properties and can have harmful effects to human health and the environment. It is thus proposed to set restrictions on use of certain compounds or function substance groups of particular relevance. Reducing the potential for the leaching of hazardous substances from road surfaces to the surrounding environment or from the removal of road markings is of high importance.[150]

In the **core** and **comprehensive criteria** for road marking the following restrictions are proposed: maximum concentration limit of 0.1% per compound for the phthalates identified as substances of very high concern and listed in the candidate list of the REACH Regulation and metals: cadmium, lead, chromium VI, mercury, arsenic, selenium (see Table 52). These include a number of substances identified under Art. 59 of REACH as substances of very high concern, for example lead chromate which was used as a yellow pigment.

160 Explanatory note: REACH Art 33(1) does not refer to mixtures (such as paints and most road markings formulations), but only to articles. Articles usually found in road markings that are not mixtures are structural plastic systems and preformed road marking products defined as tape, preformed cold plastic road marking or preformed thermoplastic road marking. In this case, Article 33 (1) of REACH applies: Under this article, suppliers (this also includes the professional shops from which the article is purchased and the article producers or importers) have to provide recipients (in this case procurers) information about the safe use of the article. As a minimum, shall be communicated to the recipient (in this case procurer) the name of the candidate list substance(s) that is in the article, if they are present in concentration of more than 0,1% of the article weight.

Table 52: Metals proposed to be restricted in GPP road markings

Name	Concentration limit
Cadmium Lead Chromium VI Mercury Arsenic Selenium.	0.01% per metal

In addition it is asked that **preservatives** used shall not be bioaccumulative and any associated risk mitigation measures shall be implemented. These restrictions are based on the results of the work conducted in the framework of the EU Ecolabel criteria development.

Regarding **verification** to prove compliance with the criterion ingredients concentrations meeting the limits for specific substances established in the criterion shall be checked using Safety Data Sheets obtained from raw material suppliers. Of the substance groups chosen for restrictions metals have a test method which can be specified to provide high level of assurance to procurers.

5.3.1.2 Criterion 2 Content of hazardous ingredients in glass beads

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
2. Content of hazardous ingredients in glass beads The glass beads used shall not contain arsenic, antimony and lead at individual concentrations exceeding 200 ppm. **Verification:** The tenderer shall provide a test report verifying the concentrations of the specified substances present in the glass beads according to EN 1423 or equivalent.	**2. Content of hazardous ingredients in glass beads** The glass beads used shall not contain arsenic, antimony and lead at individual concentrations exceeding 150 ppm. **Verification:** The tenderer shall provide a test report verifying the concentrations of the specified substances present in the glass beads according to EN 1423 or equivalent.

Rationale

In accordance with EN 1423[161] glass beads are defined as 'transparent spherical glass particles, used to provide night visibility for the road markings by retroreflecting the incident headlight beams of a vehicle towards the driver'.[162]These have been specifically included as criteria set as they were identified as environmental hot-spot in the LCAs studies review.

The below given standards apply for road markings glass beads:

- EN 1424 Road marking materials –Pre-mix glass beads,

161 EN 1423: Road marking materials - Drop on materials - Glass beads, antiskid aggregates and mixtures of the two.

162 'Note: This product is defined by five characteristics: refractive index, maximum weighted percentage of defective glass beads, granulometry, content of dangerous substances and resistance to chemicals. In addition, surface treatment with its intended use need to be declared by manufacturer (if any)'.

– EN 1423 Road marking materials – Drop on materials – glass beads, anti-skid aggregates and mixture of the two.

Road markings are mentioned among potential input sources of contamination to road surface with some metals, like arsenic, antimony, cadmium or lead. These metals have negative influence on human health and the environment. For instance arsenic can contribute among others to loss of hair, damage of liver, gastroenteritis or cancer etc.[163] Similarly, antimony, cadmium and lead exposure have serious human health and environmental impacts (see also section 4.1.2.2.3). Road markings originating from recycled glass may contain some amounts of these metals. Due to the fact that they are applied directly on roads and due to the vehicles passage as well as potential influence of UV radiation, temperature, rainfalls, aging process etc. these substances may be released from the road marking.

Metals on the road surface (which originate mainly from the transport but also the road materials) are bound to the road dust and other particulates. Precipitation either makes them dissolve or be washed off with the dust and be released directly to the environment; either via the soil or the aquatic one, depending among other on the chemical nature of metals, soil particles and the present pH value. Soil bound metals stay in the soil, while soluble ones can be transported and are more readily available to plants and animals.[164]

Glass beads and transparent anti-skid aggregates in glass are produced mainly from recycled glass (of domestic and industrial origin). Due to the fact that in the past metals like arsenic (As), antimony (Sb) and lead (Pb) were used to manufacture glass (as colouring and refining agents), control of the content of those hazardous is of high importance. According to information received along the consultation process, better furnace technologies allowed glass manufacturers to eliminate these toxic additives in production processes. Nevertheless, as glass beads in their intended use are spread into the environment, the presence of these substances needs to be controlled.[161] Also due to the fact that glass beads are partially imported from other countries outside of the EU, where such technologies might not be available.

In accordance with EN 1423 standard each element (As, Pb, Sb) shall be separately classified into one of the following two classes:

– Class 0: no value requested,
– Class 1: ≤ 200 ppm (mg/kg).

Recommendations made by the US Responsible Purchasing Network make a similar recommendation based on Class 1 and US EPA test methods.[150]

In order to prevent emissions of toxic metals from road marking products to the environment, it is considered important to limit the allowed content of these substances in glass bead produced from recycled glass. For the purpose of the GPP criteria it is proposed to require that the glass beads shall not contain arsenic, antimony or lead at individual concentrations exceeding 200 ppm, as it is specified in the EN 1423 standard, in **core** criteria. For **comprehensive** criteria, for the promotion of best environmental practices under the GPP scheme it is relevant to allow as an optional declaration lower concentrations of 150 ppm.

Regarding **verification** of compliance with the criteria a test report verifying the concentrations of the specified substances present in the glass beads according to EN 1423[165] or equivalent shall be provided by the tenderer.

163 Arsenic and Arsenic Compounds, Ullmann's Encyclopedia of Industrial Chemistry, Sabina C. Grund, Hanusch K. and Wolf H. U., published online 2008.

164 Northern Virginia Soil and Water Conservation District, Heavy Metal Pollution, available online at: www.fairfaxcounty.gov/nvswcd/newsletter/heavymetal.htm, accessed May 2014.

165EN 1423 - Road marking materials. Drop on materials. Glass beads, antiskid aggregates and mixtures of the two.

Follow-up from stakeholders' consultation

The previously given limit values were not found too strict. Additional literature research revealed that Australia and New Zealand recommend a maximum of 50 ppm for As, Sb, and Pb, and 10 ppm as a maximum for Cd, Hg, and Cr[166]. This is significantly lower than the values required in the EN 1423. Sandhu et al (2013)[167] analysed glass beads coming from Europe, Australia and New Zeeland. They noticed that average concentrations of selected metals ranges from: 103 to 683 mg/kg for As, 62 to 187 mg/kg for Sb, 23 to 179 mg/kg for Pb.

Due to lack of comprehensive information on the usual contents of heavy metals in glass beads in Europe, and especially taking into account that recycled glass should be promoted, setting such strict values seems pre-mature. It is considered however reasonable to propose the lower value of 150 ppm in the **comprehensive criteria** in order to stimulate using the beads with lower content of these harmful substances. This would entail an optional declaration of lower concentrations than those specified in the EN 1423 standard, in this case of 150 ppm.

Regarding the **verification**, one stakeholder proposed also declaration from the glass beads supplier and not only test report should be accepted. However, as the proposal refers to a test that is anyway necessary for the CE marking it was considered to keep the test in the verification part of the requirement.

5.3.1.3 Criterion 3 Quality and durability of road marking system

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
3. Quality and durability of road marking system *(Same for core and comprehensive criteria)* The tenderer shall demonstrate that the road marking maintains the minimum performance requirements, namely for night time visibility, day time visibility, skid resistance and erosion, after a defined number of wheel passages[1], as specified by the procurer in the call for tender. *[1] Indicatively, a reasonable performance could be considered as 500.000 wheel passages, according to standards EN 1824 and EN 13197. If a higher level of performance is desired, then a higher number of wheel passages should be specified.* **Verification:** The tenderer shall provide a test report or the approval of a national test facility demonstrating compliance of the road marking system under the conditions appropriate to the contract and according to EN 1824, EN 13197 or equivalent. To ensure comparability, the contracting authority shall specify in the call for tender the test method to be used by all tenderers.	

166 DR 06734 Amendment 1 to AS/NZS 2009:2006 - Glass beads for pavement marking materials.

167 Sandhu N.K., Axe L., Jahan K., Ramanujachary K.V. and Coolahan K., Environmental Impact of Metal and Metalloid Leaching from Highway Marking Glass Beads, Environ. Science & Technology, 2013, 47 (9), pp 4383–4391.

Rationale

The functional life of a road marking is defined in EN 1436 standard[168] as a period during which the road marking fulfils all the performance requirements of the classes initially specified by the road authority. The durability of road markings is understood as maintenance of main functions. It plays a key role in the evaluation on the environmental performance of road marking. The more durable the road marking, the less often repainting/refreshing needs to be conducted and the lower all related environmental impacts (related to manufacture of the road marking, its supply, application, etc.).

In order to measure the durability road tests or wear simulator tests are conducted. In a trial the material applied on to a road surface is exposed to certain number of wheel passages in combination with weather and climate conditions. In a wear simulator test, the material applied on to a test plate is also exposed to wheel passages. Finally, also laboratory tests are undertaken under pre-selected testing conditions.

The three types of methods used in various Member States to evaluate certain aspects of durability of the road marking materials are described in the following voluntary European standards:

- laboratory tests in EN 1790[169]and EN 1871[170],
- wear simulator in EN 13197[171],
- road trials in EN 1824[172].

Performance characteristics of road markings are defined by EN 1436. Road markings shall meet the minimum requirements to ensure a good level of safety and functionality at day and night, even on wet roads (see Table 53).

Table 53: Minimum required characteristics for road markings

Characteristics	Conditions	Specification
Night-time visibility* ($mcd/m^2.lx$)	Dry	≥100 (White) ≥80 (Yellow)
	Wet	≥ 25
Day-time visibility* ($mcd/m^2.lx$)	Coefficient under diffuse lighting luminescence	≥100 (Asphalt) ≥130 (Concrete)
Skid resistance **	--- x ---	≥ 45

* Not specified for road markings having other colour than white or yellow for which only skid resistance and erosion shall be tested.

** Skid resistance test cannot be performed on road markings with textured surface (for instance structured road markings) thus no skid resistance shall be specified for such road markings.

In accordance with the EN 1824 the performance classes (roll-over classes) for permanent road marking are as follows:

168 EN 1436 - Road marking materials - Road marking performance for road users
169 EN 1790 - Road marking materials. Preformed road markings.
170 EN 1871- Road marking materials. Physical properties.
171 EN 13197 - Road marking materials - Wear simulator Turntable.
172 EN 1824: Road marking materials - Road trials.

Table 54: Roll-over classes for road markings

Roll-over class	Number of wheel passages
P0	≤ 50 000
P1	Between 50 000 and 60 000
P2	100 000 ± 20 %
P3	200 000 ± 20 %
P4	500 000 ± 20 %
P5	1 000 000 ± 20 %
P5.5	1 500 000 ± 10 %
P6	2 000 000 ± 10 %

Source: EN 1824

While in accordance with the EN 13197 they are as follows:

Table 55: Traffic classes for road markings

Traffic classes	Number of wheel passages
P0	≤ 50 000
P1	50.000 (optional)
P2	100 000
P3	200 000
P4	500 000
P5	1 000 000
P6	2 000 000
P7	4 000 000

According to information received from the industry stakeholders, testing with EN 1824 are widely used in many European countries (including France, Belgium, Austria, Czech Republic, Slovakia, Poland, Croatia, Hungary the Netherlands and the UK). EN 13197 is used e.g. in Germany and Spain. Laboratory tests are mainly used in Denmark, Sweden, Finland and Greece. Elsewhere in Europe there are no fixed testing standards. It is understood that CEN TC 226 works currently on harmonisation of standards.

It was proposed by stakeholders that systems reaching class 4 or higher shall be considered as durable, high quality marking. It was indicated that testing in accordance with EN 1824 or EN 13197 could be accepted. However, the difficulty of comparing results from different test standards and the variations in requirements across Europe described above make setting a criteria challenging.

In another detailed comment provided it was proposed that wear characteristics, respectively durability of the road marking system shall be tested by wear simulation test according to EN 13197 using test plates with smooth to medium roughness equal to maximum 0,70 ± 0,10 (RG0 to maximum RG2). It was proposed that performance features could be requested to be maintained after 500 000 and 2 000 000 wheel passages for the for the core and comprehensive criteria, respectively, which should promote even more environmentally favourable products. Field test results obtained according to EN 1824 meeting above characteristics shall also deem to comply with the corresponding requirement.

Regarding **verification** of compliance with the criterion the tenderer shall provide a test report or the approval of a national test facility demonstrating compliance of the road marking system under

the conditions appropriate to the contract and according to EN 1824, EN 13197 or equivalent. Due to the issue of comparability of results a tenderer should choose one testing procedure for the verification. In the case of countries with requirements based on laboratory tests or which have not yet fixed the features it is proposed that the procedure should be as a minimum EN 13197.

Follow-up from stakeholders' consultation

The stakeholders mentioned that both field test (EN 1824) and wear simulator (EN 13197) provide tools to evaluate different aspects of durability. It was stated that from the point of view of reproducibility, cost and time line perspective EN 13197 should be specified as the standard and EN1824 certification shall be accepted wherever available.

There is no correlation between field testing (EN 1824) and wear simulator testing (EN 13197) results, which makes setting absolute value impossible, while accepting still the two testing methods. And that even on the same field test results are not very consistent when comparing the same material applied at a different spots.

Wear simulator testing according to EN 13197 provides well controlled test conditions; nevertheless, its disadvantage is that, it simulates the wear by a certain tires, shear and load characteristic only. It is accepted in many European countries[173]. Its costs range from 2000 Euro for P5 type I systems to 3500 Euro for P7 type II. The results can be obtained within a few months.

In comparison, cost for field tests are significantly higher (above 10000 Euro per system) and the duration of the test is also much longer (years). An example from France was provided. France uses field certification according to EN 1824 on national highway N2. New road marking systems can be applied in beginning of June. The applied system performance is observed over a period of up to one year with up to one million wheel passages on the system (P5 certification). Counting in the administrative procedure it takes minimum two years to obtain a P5 certificate.

Stakeholders highlighted, that it should also be taken into account that the actual application conditions (like temperature, humidity, pavement conditions, equipment and other factors) have impact on the functional life of a road marking. Beside this, obviously, the actual traffic wear, location, topography and climatic condition also play a role. For instance, in countries with colder climate snow plow and/or de-icing agents during harsh winters considerably impact the system performance and obtain consistent results from different years (certification periods) is very difficult. The same refers to results obtained from test filed located at sea side, where a heavy sand load influences the road marking lifetime and the results differ from those obtained in locations without sand flow.

As road markings are covered by the Construction Products Directive and should have CE marking a common testing methods should be agreed for the European market. This is however not the case at present and works are ongoing. For the time being both test methods shall be allowed and the procurer shall specify the standard which should be used for a particular call for tender, depending on the methods applied in the given MS or region.

To certain extent there were split views regarding the minimum class required in both core and comprehensive criteria. Some stakeholders supported the minimum class P4 for core criteria, while one proposed to set the level at P5 performance class. Similarly, there was some support regarding the P6 performance class for comprehensive criteria, with one voice stated that specifying class P6 without specifying further parameters is not ambitious enough. There are better performing systems available on the market and industry would be discouraged from increasing R&D efforts to develop even better solutions. It should be however remembered that the GPP criteria stimulate and

173 According to information received – in Estonia, Lithuania, Latvia, Luxemburg, Greece, Hungary, Bulgaria, Croatia, Slovenia, Serb and parts of Italy.

promote use of products which are more environmentally friendly but are also available at the market.

One additional comment was received regarding the minimum performance characteristics, which according to the association, shall be amended as presented in their position paper: "Marking the way towards a safer future - An ERF Position Paper on how Road Markings can make our road safer future"[174]. Various research projects have been and are being conducted at present in the area of road marking functionality and safety on roads. In particular the following areas are addressed through various projects conducted by industry and research or testing institutes.

- durability of the applied marking,
- visibility and retro-reflectivity, in particular wet night retro-reflectivity,
- relation between the drivers age, the visibility of the marking and the safety on roads in a broad sense (reaction speed).

In the paper of ERF the results of various studies regarding state of the existing road markings, public spending on markings, needed minimum performance factors and their dependence on the e.g. age of the driver are analysed. ERF states that the analysis of the state of road markings in various Member States shown that the serious deterioration of the quality of markings on Europe's road network can be observed. This contributes to decrease of safety on roads. The association proposes establishing *a comprehensive policy for the maintenance of road markings and the establishment of a minimum intervention policy which can guarantee that markings do not fall under a specific performance*. According to the proposal of ERF the *performance should not be allowed to drop below 150 mcd/lux/m² (R3) in dry weather conditions and 35 mcd/lux/m² (RW2) in wet and rainy conditions.*

In criteria set is proposed that it shall be up to the procurer to specify, depending on their specific needs (e.g. the road type, location, linked climatic conditions and traffic intensity) the minimum performance characteristics, which will be different for different public orders. The proposal of ERF could be an aid in this point but the works in the industry framework are ongoing at this stage.

An indication is provided that the requirement should not be inferior to 500 000 wheel passages. This is however an example only, the type of road, traffic, use conditions, ambition level, etc. need to be taken into account by the procurer while deciding on the specific performance class.

5.3.2 AWARD CRITERIA FOR ROAD MARKINGS

5.3.2.1 Criterion 1 Road marking formulation - White pigment (titanium dioxide) content

Core criteria	Comprehensive criteria
AWARD CRITERIA	
1. Road marking formulation – White pigment (titanium dioxide) content *(For call for tenders where specific quality and durability requirements are set)* Points shall be awarded to the bidder with a product showing a lower white pigment content	**1. Road marking formulation – White pigment (titanium dioxide) content** *(For call for tenders where specific quality and durability requirements are set)* Points shall be awarded to the bidder with a product showing a lower white pigment content

174 European Road Federation, Marking the way towards a safer future: An ERF Position Paper on how Road Markings can make our road safer, available online at: http://www.irfnet.eu/images/ERF_Paper_on_Road_Markings_Released.pdf.

than the following limits: - for systems applied at <1 kg/m^2: <14 % TiO_2, - for systems applied at >1 kg/m^2: <10 % TiO_2. **Verification:** The tenderer shall provide documentation for the product formulation, supported by test results or declaration of conformity of the relevant homologation body[2], showing the content of white pigment. *[2] An homologation body is an official body that carries out the certification and pre-approval of products in accordance with specific performance criteria for use at national, regional and/or local level.*	than the following limits: – for systems applied at <1 kg/m^2: <10 % TiO_2, – for systems applied at >1 kg/m^2: <8 % TiO_2. **Verification:** The tenderer shall provide documentation for the product formulation, supported by test results or declaration of conformity of the relevant homologation body[2], showing the content of white pigment. *[2] An homologation body is an official body that carries out the certification and pre-approval of products in accordance with specific performance criteria for use at national, regional and/or local level.*

Rationale

As explained in section 4.1.1 white pigment content is one of the key environmental aspects for paints and similarly for road markings. It must be nevertheless also mentioned that the content of titanium dioxide is linked to the performance and durability of the road marking, which is of outmost importance for the overall environmental performance of the road marking system. TiO_2 is also partially responsible for providing retro-reflection of a car's headlight at night. Therefore, as informed by manufacturers, the content of TiO_2 needs to be higher in road markings than in decorative paints. In accordance with data provided, in paint road marking systems its content can be around 20%, while for thermoplastic and cold plastics around 10%.

In order to ensure reduced use of white pigment on the one hand and the durability of the product whilst on the other hand, some stakeholders proposed to associate the GPP criterion on maximum white pigment content with either the durability classes or the projected lifespan of the marking in years. Class P5 was considered by the industry as indicating high durability of the marking.

There are two main standards used in Member States to define the performance classes of road markings: EN 1824, which is based road trials and EN 13197 which is based on simulated trials. This is discussed in more detail under the criterion related to abrasion resistance of road marking.

The consultation process did not result in an agreed version of this criterion. It has been highlighted that because different testing standards are used across the EU (road trial vs simulated trial conditions) the results will not be comparable. The road trials are also dependant on various conditions, traffic load, and climatic conditions. In various MS one or another method is used, in some there is no agreed procedure. Additional complexity arises from the fact that in some Member States, for example Germany, there are in force legal requirements establishing a minimum thickness of the road marking layer, understood to approximate to 0.5 kg/m^2 of road paint, which will also directly influence the content of TiO_2.

In the interim the following proposal was put forward by industry stakeholders for the **core and comprehensive criteria**: White pigment content shall be equal to or lower than the limits given in Table 56:

Table 56: Requirement on white pigment content in road markings

Performance class	Core criteria TiO_2limit (g/m^2)	Comprehensive criteria TiO_2 limit (g/m^2)
P5	200	70
P6	400	150

This proposal was linked to performance classes for the number of wheel passages during testing, with the data presented relating to P5 and P6. This is largely understood to be based on results from testing in France but would still be subject to variability depending on the road marking product and the test method. An alternative approach would be to normalise for comparability the TiO_2 limit to be achieved based on either the projected lifespan of the road marking or, with reference to performance classes, the number of wheel passages. Table 57 shows that in order to minimise the life cycle usage of TiO_2, both projected lifespan and TiO_2 usage by surface unit (which depends on TiO_2 content in the road-marking material and on applied weights per surface unit) should be considered in combination.

It should be however added that the quality of TiO_2 is also of importance, and that the below presented values should not be regarded as absolute, but may vary depending on the quality of the TiO_2 used.

Table 57: Comparison of TiO_2 content for different Road Marking systems

Road marking system	Edge Durability (Years)	Center Durability (Years)	Application Paint Quantity $(Kg)/m^2$	TiO_2 g/kg	TiO_2 g/m^2	TiO_2 g/m^2/year
1a. Waterborne Paint standard fast drying	2.0	1.0	0.45	97.10	43.70	21.56
1b. Waterborne Paint High Efficiency	2.0	1.0	0.45	60.00	27.00	13.32
1c. Waterborne Paint High Durability	3.0	2.0	0.6	115.80	69.48	21.62
2a Solvent-borne Paint (Alkyd)	2.0	1.0	0.6	100.00	60.00	29.61
2b.Solvent-borne Paint (Acrylic)	2.0	1.0	0.6	100.00	60.00	29.61
3a. Thermoplastic Package (Cat. I)	3.0	2.0	3.0	70.00	210.00	65.34
3b. Thermoplastic Package (Cat. II)	4.0	3.0	4.0	70.00	280.00	65.03
4a. Cold Plastic (Cat. I)	3.0	2.0	1.0	100.00	100.00	31.12
4b. Cold Plastic (Cat. II)	3.0	2.0	2.0	65.00	130.00	40.45

Source: Dow (2014) based on Life Cycle Assessment Road Marking Technologies Eco-Profile. Final Report Nov. 2012. Dr. H. Kheradmand, LCT, LSA & SD Expert, DCM

An approach based on the projected life span could be specified based on a warranty period, if required by the procurer, whilst an alternative approach could be based on the performance class to be met. For example, thermoplastic markings would require white pigment to be applied up to $280g/m^2$ which, based on a projected lifespan of 3-4 years, would equate to 70-93g/m^2/year or, based on a minimum P4 performance class, 0.56 $\mu g/m^2$/wheel passage. A proposed threshold based

on wheel passages is proposed in Table 58, assuming a linear correlation between TiO_2 content and abrasion resistance.

Table 58: Requirement on white pigment content in road marking

Performance class	**Core criteria TiO_2limit** ($g/m^2/10^3$wheelpassages)	**Comprehensive criteria TiO_2** ($g/m^2/10^3$wheelpassages)
P4 – P6	0.2	0.07

Regarding **verification**, it was proposed that the tenderer provided documentation for the road marking formulation, supported by analysis results showing that the content of white pigments is compliant with this criterion. If the link to performance classes is retained then the procurer will need to specify that all the bidders use the same test method to ensure comparability of bids. For those countries where there is a requirement on minimum thickness of road marking layer an award criterion was proposed based on white pigment content.

Follow-up from stakeholders' consultation

One stakeholder expressed doubts regarding the values used for calculation in Table 57, considering them too low. However, no technical information, which could allow verification of the information provided by DOW was presented.

Another stakeholder checked the values versus their own products and confirmed that the proposed values were fine for core criteria and quite demanding for the comprehensive ones for P5 performance class. German expert stated that Type II systems existing in his MS would not comply with the requirements of the comprehensive criterion.

It was stated that only for very thin layers of about 0.20 mm or lower a higher TiO2 (>10 wt%) is needed to archive adequate hiding power and there may be certain dependants between the content of TiO_2 and durability. This refers however only to Type I and not to Type II systems.

In general, the stakeholder recognised that TiO_2 is an environmental hotspot. But again it was emphasized that it is essential for the durability of the product and its performance in terms of safety. The implications of setting an absolute max concentration on the performance would require more thorough investigation, which exceeds the scope of the current project.

Additional difficulty is linked to the fact that still no harmonised standards for testing of road markings performance exist in Europe. Thus the given in Table 58 performance classes should be fine for the EN 1824, while for instance in Germany, where EN 13197 is used and, according to information provided, P7 is the most common class.

It was stated that the currently drafted criteria (core and comprehensive) are based on the assumption that there is a direct correlation between durability of the road marking and TiO_2 content and that such a correlation does not exist in general. This is however not the intention of the criteria to base on the correlation but to award manufacturers, who manage formulate a better product, i.e. offering the same performance (tested either with EN 1824 or EN 13197) but with lower amount of TiO_2. This can be done through choice of the formulation ingredients, e.g. higher quality TiO_2, choice of binders, etc.

Some stakeholders proposed to refer to the French scheme – NF331 - NF Environnement

- Horizontal road marking products[175], which states that the products shall have a content in white mineral pigments TiO_2 less than or equal to:

175 More information available online at: NF331 - NF Environnement - Horizontal road marking products, http://www.marque-nf.com/en/nf-for-professional/which-nf-certification-should-i-choose/.

- 200 g/m² of dry film for paint,
- 400 g/m² of dry film for plastic or for preformed marking.

However, discussion with the NF representatives was conducted; however the reasoning for setting these thresholds was unavailable.

Alternative proposals were also provided from a MS, where there are requirements on the minimum film thickness:

1) Two criteria on white pigment content depending on lasting could be set:

- normal lasting (solvent borne or water borne) coatings: 0,2 g/m²*10³ wheel passages,
- long lasting coatings (multicomponent plastics (cold coating): 0,8 g/m²*10³ wheel passages.

2) Or maximum content based on thickness, instead of surface: 0,2 g/m²*10³ wheel passages • mm thickness could be proposed.

Nevertheless; to evaluate all the above proposals, data is missing on the content of the pigment and corresponding performance.

One more proposal was provided in order to accommodate both, thin and thick layer systems. It is formulated as follows:

- Core criteria:

Systems applied at <1 kg/m²: <14wt% TiO_2

Systems applied at >/=1 kg/m²: <10wt% TiO_2

- Comprehensive criteria:

Systems applied at <1 kg/m²: <10wt% TiO_2

Systems applied at >/=1 kg/m²: <8wt% TiO_2

It is proposed to consult it with the stakeholders in the current consultation round. It would allow for setting some minimum requirement levels.

It is now understood better how the real durability or life span of a road marking depends on the specified functionality. And that there is a substantial difference depending if there is or not a requirement on the night-time visibility (retro-reflectivity), and (even more challenging) if there is a requirement on wet night retro-reflectivity. These will influence the choice of the system by the procurer and to certain extent also the content of TiO_2. '*To obtain night-time visibility of a road marking, respectively retro-reflectivity both a minimum content of TiO_2 and a minimum presence and a minimum size of retro-reflecting glass beads at the surface of the road marking material is required, whereby glass bead dimension requires a minimum thickness of the road marking material to anchor the beads in the pigmented material*'.

Beside the quality of TiO_2 and the colour of the fillers in the formulation which influence the performance parameters of the road marking, also factors like the *'road texture and the characteristics of the pavement influence the minimum thickness required to obtain Type I retro-reflective character (usually 0.25-0.4 mm required) and Type II spray applied road markings (respectively about 0.4 to 0.7 mm for)*'.

It is thus understood that at the current state of knowledge it is challenging to propose minimum thresholds for the different systems and applications in the EU linking them with performance factors.

It is proposed to set requirements on titanium dioxide separately for thin and thick applications. Consulted stakeholders indicated the thickness of 1 kg/m² as the most appropriate to differentiate

between thin and thick systems. Points shall be awarded to the bidder who offers products showing white pigment content lower than:

Core criteria	Comprehensive criteria
– for systems applied at <1 kg/m^2: <14 % TiO_2, – for systems applied at >1 kg/m^2: <10 % TiO_2.	– for systems applied at <1kg/m^2: <10 % TiO_2, – for systems applied at >1kg/m^2: <8 % TiO_2.

This refers to the road marking material excluding the beads.

Regarding the values, some stakeholders proposed to increase them for the comprehensive criteria (to keep the values given in the core criteria also for the comprehensive ones), while others proposed to lower the threshold from 8 to 6% for systems applied at >1kg/m^2. This could be however difficult to be met for high quality water-based systems. It is proposed to keep the above given thresholds.

As **Verification** appropriate documentation for the paint formulation, supported by test results or declaration of conformity of a relevant homologation body, showing the content of white pigment shall be provided.

5.3.2.2 Criterion 2 Glass beads – Recycled glass content

As mentioned before, glass beads in road markings are used to achieve retroreflection. They are partially embedded on the surface of the marking binder material. There are two principle kinds of glass beads: 1) used as intermix for thermoplastic marking or 2) drop-on beads.[176]

Two important field properties of beads are the amount and dispersion across a line and the depth of embedment of the beads. They are influenced by: bead drop rate, speed of the striping truck, temperature, and viscosity of the binder material, etc. During the manufacturing process the following features of beads (chemical and physical), which have a significant influence on the retroreflection of light, can be controlled: bead size, refractive index, clarity and roundness.[176]

Regarding size, it shall be mentioned that bigger beads have slightly higher retro-reflectivity under dry conditions (but no on refractive index). In wet conditions, the film of water that covers the marking causes that the light scatters before it can enter the bead. Therefore, large beads are more effective when roads are slightly wet. They protrude through the water film better than smaller beads. But this is also dependant on the thickness of the film (the thicker the film the larger beads more lose their effectiveness).

'The refractive index (RI) is a function of the chemical makeup of the beads, which is determined by the raw material used to make the bead. The higher the refractive index, the more light is retroreflected'.[176] Higher refractive indices are achieved by beads made from virgin glass than from recycled glass. But these beads are normally more expensive. Transparency and roundness are also important. Transparency ensures that the light passes through the bead and it is not partially blocked by the material. While rounded surface *'causes the light ray to bend downward to a point below where the bead is embedded in the paint. Light striking the back of the embedded portion of the bead is reflected back to the path of entry*'.[176]

176 Lopez, C. A., Online Manual: Pavement Marking Handbook, 2004, available online at: http://onlinemanuals.txdot.gov/txdotmanuals/pmh/glass_beads.htm, accessed May 2014.

Core criteria	Comprehensive criteria
AWARD CRITERIA	
	2. Glass beads – Recycled glass content *(For purchase of road marking containing glass beads to fulfil the specified grade of night time visibility and retro-reflectivity set in the call for tender. This criterion is not applicable when special properties, such as high retro-reflectivity requirements, are specified by the contracting authority.)* X points shall be awarded in proportion to the recycled content (by mass) of the total amount of glass beads used to fulfil the contract. The recycled content shall be calculated on the basis of an average mass balance of the raw materials used (in accordance with the methodology prescribed in ISO 14021). • Between 75% and 100% recycled glass content - 100% of points awarded • Between 50% and 75% recycled glass content - 75% of points awarded • Between 25% and 50% recycled glass content - 50% of points awarded • Less than 25% recycled glass content - no points awarded The specified grade of night time visibility and retro-reflectivity in wet conditions set in the call for tender shall be met. **Verification:** The tenderer shall provide third-party verified documentation from the glass bead manufacturer(s) indicating the recycled content (by mass) of the total amount of glass beads used to fulfil the contract. Upon award of the contract, or upon request from the contracting authority, the tenderer shall provide third-party verified documentation describing the calculation (according to the methodology prescribed in ISO 14021) of the said recycled content, as well as third-party verified records of the data supporting the said calculation including, as a minimum, batch and factory production control system (operated in accordance with EN 1423 or equivalent[1]) documentation.

	[1] *This could include ISO 9001 or a national or international scheme for verifying the traceability of recycled content.*

Rationale

Glass beads can be made from virgin or recycled glass. Due to the fact that glass manufacturing is a highly energy consuming process, use of recycled materials conserves energy and resources, and allows additionally reduction of pollution related to raw materials extraction and energy production and consumption.[177] Recycled glass for beads can originate from both – manufacturing and postconsumer waste. Collected glass is sorted and crushed to customized sizes, depending on its intended application method and the type of road marking it will be used with. It is understood that the flat glass is the main source of feedstock. Application of glass beads in road markings created a market for material recovery and allowed avoiding necessity of disposal of waste glass.[178]

In accordance with the information provided along the consultation process by the stakeholders, there are two classes of glass beads used as drop-on materials. They provide different functionality, which at the same time requires different levels of quality and is reflected in the glass feedstock. In general glass beads are mainly made of recycled glass. Nevertheless, high index beads are made from virgin glass. They are typically used when special properties such as the highest classes of retroreflection during continuous rain (RR) are required.

Follow-up from stakeholders' consultation

Explanatory information was provided regarding the use of beads by the industry association. It was explained that *Type I and Type II performance cannot be directly correlated to a bead size or to a chemical composition. The wet reflectivity performance relates only to the applied system (bead size, road marking material, film thickness, structure etc.) and not to the single road marking components.* It was suggested that *referring* to Type I and Type II beads is confusing and should be avoided. Respective text was amended in the text.

Due to the fact that another criterion on glass beads is withdrawn, and knowing that glass beads contribute to environmental impacts along road markings life cycle, it is proposed to award points for higher use of recycled glass.

It is proposed to support the use of recycled glass in road markings and to set a **comprehensive award criterion** which addresses the content of recycled glass. Points shall be awarded to the tenderer proportionaly to the recycled glass content of the offered products. If the purchaser specify special properties (such as very high retro-reflexion requirements) awarding points might not be possible.

Regarding **verification** of compliance of the tendered product with the criteria recycled glass content, the tenderer shall provide third-party verified documentation from the glass bead manufacturer(s) indicating the recycled content (by mass) of the total amount of glass beads used to fulfil the contract. Upon award of the contract, or upon request from the contracting authority, the tenderer shall provide third-party verified documentation describing the calculation (according to the methodology prescribed in ISO 14021) of the said recycled content, as well as third-party verified records of the data supporting the said calculation including, as a minimum, batch and factory production control system (operated in accordance with EN 1423 or equivalent) documentation.

This could include ISO 9001 or a national or international scheme for verifying the traceability of recycled content.

177 Kankan-Dwumfour E., Recycled glass bead production in selected towns in Ashanti, Industrial Art Ceramics, 2009.

178 Utilization of Recycled Materials in Illinois Highway Construction – Glass Beads, US Department of Transportation, Federal Highway Administration, 2001, available online at: http://www.fhwa.dot.gov/pavement/recycling/recbead.cfm, accessed May 2014.

5.3.3 CONTRACT PERFORMANCE CLAUSES FOR ROAD MARKINGS

5.3.3.1 Criterion 1 Technical support and site inspections

Core criteria	Comprehensive criteria
CONTRACT PERFORMANCE CLAUSES	
1 Technical support and site inspections *(Same for core and comprehensive criteria)* The contractor shall provide technical advice and site works instructions to the Contracting Authority or their contractors. This shall include the following: • Method statements and guidance on substrate preparation, • Method statements and guidance on product preparation, including estimates for application per m^2, • Optimal conditions for storage and application of the product, including support in selecting and using application equipment, • Risk mitigation measures to minimise environmental pollution, • Advice on appropriate disposal of unused product. Technical advice shall also be made available, upon request, to the site-operatives of the Contracting Authority or their contractors either in the form of on-site visits (in a number and scope to be specified by the contracting authority at tendering stage) or a technical hotline (in a language specified by the contracting authority). The tenderer shall provide documentation which contains the listed information. Written feedback from the operatives applying the road marking product shall confirm satisfactory provision of technical advice and site support.	

Rationale

As explained in a respective requirement for paints, in order to ensure appropriate application of the road marking product and that the appropriate amount of the product is purchased (i.e. the product is not wasted) it is considered important to address technical advice and site inspections aspects in the frame of GPP criteria. This advice shall cover the following:

- Method statements and guidance on substrate preparation and paint preparation,
- Optimal conditions for storage and application of the product,
- Risk mitigation measures to minimise environmental pollution,

It is proposed that the tenderer shall additionally provide estimates for the amount of road marking required in different applications per m^2. This will aid more accurate estimation of the amount of product needed for the specific work the public authority intends to contract.

In addition, it is proposed that upon request for larger works site visits by technicians from the manufacturer shall also be available to ensure proper application of the product and its subsequent appropriate performance along the life cycle. Given that the application of road markings requires specialist equipment it is considered that training should also be provided in order to optimise a product's application.

The tenderer shall provide documentation which contains requested information. Written feedback from the operatives applying the road marking product shall confirm satisfactory provision of technical advice and site support.

5.4 ROAD MARKINGS WORK CONTRACTS

In the section of the report aspects and requirements related to work contracts are presented. As explained in the Section on painting work contracts, initially it was intended to keep the GPP criteria for painting and road marking application road contracts together in one set. Nevertheless, after extensive consultation with stakeholders from the road marking sector it was agreed that due to differences in application, product characteristics, its function and safety reasons (that last for road markings) the criteria for painting services and road marking application should be kept separate.

5.4.1 SELECTION CRITERIA FOR ROAD MARKING CONTRACTS

5.4.1.1 Criterion 1 Competencies of the tenderer

Core criteria	Comprehensive criteria
SELECTION CRITERIA	
1. Competencies of the tenderer *(Same for core and comprehensive criteria)* The tenderer shall demonstrate professional competencies in the following areas, as relevant to the nature of the contract being let: • Method statements for the efficient use of road marking on-site, including the preparation of estimates and the use of specialist equipment; • Method statements for the preparation of substrates (including, where appropriate, safety procedures for removal of road markings which may have been made with lead pigment and are considered hazardous; or high pressure removal of road markings); • Method statements for the preparation of road marking formulations and their handling during their application; • The application of environmentally improved products, including those with reduced VOC content; • The application of durable and high specification finishes, with reference to relevant EN standards or their equivalent; • Policies and supporting management systems to minimise road markings waste, maximise the reuse or recycling of waste and unused road marking and to ensure their safe disposal and safe disposal of other chemicals such as road marking stripping agents. **Verification**: The tenderer shall provide evidence in the form of information and references related to relevant contracts in the previous 5 years in which the above elements have been carried out.	

Rationale

Similarly as for the painting work contracts, the selection criteria are related to the capacity of bidders to perform the contract.[179] In order to be selected for the service the tenderer needs to demonstrate a range of professional competencies in the areas relevant to the nature of the contract. For the purpose of these GPP criteria it is considered that the most important competencies encompass:

179 European Commission 'Buying Green Handbook', 2011, available at: http://ec.europa.eu/environment/gpp/buying_handbook_en.htm.

- Method statements for the preparation of substrates (including, where appropriate, safety procedures for removal of road marking which in the past have been made with lead pigment and are considered hazardous);
- Method statements for the efficient use of the product on-site, including the preparation of estimates and the use of specialist equipment;
- The application of environmentally improved products, including those with reduced VOC content;
- Policies and supporting management systems to minimise road marking waste, maximise the re-use or recycling of residual road marking and to ensure safe disposal of waste road marking and other chemicals such as stripping agents.

The same requirements apply to both, **core and comprehensive criteria sets**.

Regarding **verification** of compliance the tenderer shall provide evidence in the form of information and references related to relevant contracts in the previous 5 years in which the above elements have been carried out.

5.4.2 TECHNICAL SPECIFICATIONS FOR ROAD MARKINGS CONTRACTS

5.4.2.1 Criterion 1 Use of road markings meeting the EU GPP criteria

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
1. Use of road markings meeting the EU GPP criteria *(Same for core and comprehensive criteria)* All work contracts shall be performed using road marking products that comply with the EU Green Public Procurement requirements as specified in Technical specifications for core criteria of EU GPP – Section 4.3 Road markings. **Verification**: The tenderer shall provide supporting documentation that the products used meet the criteria specified above.	

This criterion was introduced in order to ensure that the criteria for environmentally preferable products and for work contracts are used simultaneously by the procurers who intend to purchase "a service and a product in one tender".

5.4.2.2 Criterion 2 Management of waste and unused road marking material

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
2. Management of waste and unused road marking material *(Same for core and comprehensive criteria)* The tenderer shall submit a waste management plan for road marking material leftover from the preparation of the substrate and application. The plan shall include: • Where demarking needs to be conducted, an assessment for the potential hazardous content of road marking material that has been stripped from substrates and, if a risk is identified, a method statement for mitigating the risk by safe handling and disposal. • A method statement shall be provided for on-site practices in the cleaning of equipment and the storage of waste and unused road marking material for safe disposal as hazardous waste. • Measures to minimise waste and unused road marking material. **Verification:** The tenderer shall provide a documented waste management plan which shall include method statements for safe demarking, equipment cleaning and waste and unused road marking material handling and disposal, as well as the measures applied to minimise waste and unused road marking material. *Monitoring of road marking material waste shall be addressed through a contract performance clause.*	

Rationale

As indicated in section 4.1 on LCA of paints, unused paint or unused road marking material is one of the environmental issues of concern. It can be considered hazardous waste and its amount should be kept as low as possible.

In general, there lacks data about the shares of road marking materials left unused after completing the application process and wasted. Monitoring of the amount of road marking waste is addressed in the framework of contract performance clauses.

Further, it is considered important that a tenderer has or establishes a waste management plan for road marking material leftover from the preparation of the substrate and application. This plan shall ensure safe handling, storage and disposal of the paint. In addition, indications regarding appropriate practices for demarking and equipment cleaning are of importance. The plan proposed for **core and comprehensive criteria** shall include:

- A assessment for the potential hazardous content of road marking material that has been stripped from substrates and, if a risk is identified, a method statement for mitigating the risk by safe handling and disposal.
- A method statement for on-site practices in the cleaning of road marking equipment and the storage of waste and unused road marking material for safe disposal as hazardous waste. The on-site system for washing the road marking equipment in order to prevent the residues from road marking material entering the drainage system could be an effective example of one of such practices.
- A description of measures to minimise waste and unused paint

Regarding **verification** of compliance with the criterion the tenderer shall provide a documented waste management plan including method statements for safe demarking, equipment cleaning and waste and unused road marking material handling and disposal. Monitoring of road marking material waste arisings shall be addressed as a contract clause.

5.4.3 AWARD CRITERIA FOR ROAD MARKING CONTRACTS

5.4.3.1 Criterion 1 Performance based contracts

Core criteria	Comprehensive criteria
AWARD CRITERIA	
	1 Performance based contracts *(Where long-term performance based road marking application and maintenance contracts are tendered)* Points shall be awarded according to the estimated volume of road marking material used to maintain the quality of the road marking during the life-time of the contract. **Verification:** The tenderer shall provide a document setting out the estimated quantities of road marking material required during the contracted program, including assumptions made about the required number of remarkings over the life-time of the contract.

Rationale

In addition to the above criterion, a second **comprehensive award criterion** is proposed for performance based road marking contracts which cover also remarking services. It is understood that overall costs can be reduced over the life-span of the contract by selecting more durable products and by more frequent preventative works to prevent deterioration of road markings. Where a contract is over longer period of time, 5 years of more, then there will be an inherent incentive for the contractor to choose road markings that are more durable.

Therefore it is proposed that points shall be awarded according to the potential for savings in road marking material use for planned, cyclical remarking by providing supplementary maintenance and remedial services for road markings. Such performance based contracts could cover maintenance services (on an agreed time-basis) and repairing damaged road marks.

Regarding **verification** of compliance with the requirements the tenderer shall provide a document setting out the estimated quantities of road marking materials required during the contracted program as well as the potential for savings on road marking material.

5.4.4 CONTRACT PERFORMANCE CLAUSES FOR ROAD MARKING CONTRACTS

5.4.4.1 Criterion 1 Management of road marking usage and application

Core criteria	Comprehensive criteria
CONTRACT PERFORMANCE CLAUSES	
1. Management of road marking usage and application *(Same for core and comprehensive criteria)* The contractor shall provide records of (*for performance based contracts*): • The quantity of road marking purchased; • The actual road marking quantities used in fulfilling the contract specifications. The contractor shall also provide records for waste and unused road marking, including tracking where it has been: • Reused by the contractor; • Reused externally; • Recycled; • Safely disposed of. The contractor shall also provide records – in case old road marking layer needed to be removed from the substrate that it has been: • Handled safely; • Disposed of safely for treatment as hazardous waste.	

Rationale

Contract performance clauses are used by public procurers to specify how a contract is to be carried out. They are related to performance of the contract, i.e. the tasks which are necessary for the production and the provision of the goods, services or works purchased. The compliance with the requirements specified in the contractual clauses is monitored along the period of carrying out of the contract.[180] For the GPP criteria set for the road marking work contracts several issues are considered as of high relevance to the performance of the contract, taking into account the previously mentioned aspects of highest relevance for the environmental performance of the service to be provided. Among them the most important include: the quantity of product purchased by the contractor to fulfil the work contract, the amount of actual product used by the contractor and the treatment of the road marking that was removed from the substrate before the renewal service was conducted. Additionally, it is considered essential that the contractor provides records on the residual road marking amount and, when applicable, on the waste management practice applied to it; i.e. whether (and what share of it) was:

- Re-used by the contractor or externally,
- Sent for recycling,
- Safely disposed of.

180 European Commission 'Buying Green Handbook', 2011, available at: http://ec.europa.eu/environment/gpp/buying_handbook_en.htm.

Further, in case the former old road marking is removed from the substrate, proper handling and channelling it to the respective stream of hazardous waste is required.

The contractor shall provide reports on the records on the residual road marking amount and, when applicable, on the waste management practice and the treatment of removed old road marking at agreed intervals along the contract duration.

6 ANNEXES

Annex 1. Technical definitions related to paint and/or road marking specifications

(1) 'White and light coloured' paints are those with a tri-stimulus (Y-value) > 70%

(2) 'Gloss paints' are those which at an angle of incidence of 60° show a reflectance of ≥ 60

(3) 'Mid sheen paints' (also referred to as semi-gloss, satin, semi-matt) are those which at an angle of incidence of 60° or at 85° show a reflectance of
< 60 and ≥ 10

(4) 'Matt paints' are those which at an angle of incidence of 85° show a reflectance of <10

(5) 'Dead matt paints' are those which at an angle of incidence of 85° show a reflectance of <5

(6) 'Transparent' and 'semi-transparent' means a film with a contrast ratio of < 98% at 120µ wet film thickness,

(7) 'Opaque' means a film with a contrast ratio of > 98% at 120µ wet film thickness,

(8) 'Volatile organic compounds' (VOC) means any organic compounds having an initial boiling point less than or equal to 250 °C measured at a standard pressure of 101,3 kPa as defined in Directive 2004/42/EC and which, in a capillary column, are eluting up to and including n-Tetradecane (C14H30),

(9) 'Semi volatile organic compounds' (SVOCs) means any organic compound having a boiling point greater than 250 °C and less than 370 °C measured at a standard pressure of 101,3 kPa and which, in a capillary column are eluting with a retention range after n-Tetradecane (C14H30) and up to and including n-Docosane (C22H46).

Annex 2. Formaldehyde testing

Requirement	Report method
A sum total formaldehyde limit of 0.0010% applies unless a derogation applies (see the row below).	The Merckoquant method shall be used. If the outcome is inconclusive, high-performance liquid chromatography (HPLC) shall be used to confirm the in-can concentration.
A higher formaldehyde limit 0.010% applies where: (i) Preservatives that are formaldehyde donors are required as an in-can preservative to protect a specific type of paint or varnish and where the formaldehyde donor is used in the place of isothiazolinone preservatives (ii) Polymer dispersions (binders) provide, through residual levels of formaldehyde, the function of formaldehyde donors instead of in-can preservatives.	Determination of the in-can formaldehyde concentration by means of analysis using VdL-RL 03 or high-performance liquid chromatography (HPLC). Indoor paints and varnishes: Determination by means of analysis[1] according to ISO 16000-3. Emissions must not exceed 0.25 ppm upon first application and they must be less than 0.05 ppm after 24 hours from the first application. Initial application is considered to be once stable air mixing in the test chamber has been achieved. It is recommended that stable air mixing can be achieved after 1 hour with the aid of a fan. In all cases the results shall be corrected to reflect a ventilation rate of 1.0 air change/hour by dividing them by 2. This ensures that the results reflect the chamber conditions used in EN 717-1 which form the basis for the emission thresholds.

[1]Equivalent standards exist which may be used, in particular CEN/TS 16516 which is intended to supersede the ISO 16000 series.

Annex 3. SVOC test method markers and modifications

Guidance on the determination of Semi-Volatile Organic Compounds (SVOC) using ISO 11890-2 (2013) (extending its scope)

***Scope**:*

This guidance interprets the specifications of ISO 11890-2 to allow the running of a test to quantify paint SVOC content, either alone or in one run together with an ISO 11890-2 VOC test, so as to evaluate compliance with the requirements of the EU Ecolabel. This guidance should therefore be read alongside ISO 11890-2, but with the modified sample preparation method, apparatus and parameters specified taking precedence.

***Sample preparation**:*

An organic solvent suitable for diluting the sample shall be used. It shall have a purity of at least 99% by mass. The recommended dilution solvent is methanol 100%. If necessary, the sample can be stirred during 30 minutes with application of ultrasound in order to achieve a homogenous liquid phase, or by mechanically stirring during two hours followed by centrifugation or a filtration step using a PTFE filter type for paints containing large, undissolved particles. In the case that a homogenous liquid phase cannot be achieved using methanol 100% then another suitable dilution solvent, such as acetonitrile or tetrahydrofuran, shall be used.

Note:

The marker compounds to be used are n-tetradecane (n-C14) and n-Docosane (n-C22). It may be necessary to prepare a marker solution containing these compounds in acetone due to the limited solubility of n-Docosane in acetonitrile.

***Apparatus**:*

Capillary column:

- The preferred choice of column shall be one made of fused silica coated with 5% phenyl / 95% dimethyl polysiloxane (slightly polar type, DB5 or equivalent).

- A column coated with 100% dimethyl polysiloxane (non-polar type, DB1 or equivalent) may be used if it can be shown to perform better for predominantly non-polar paint ingredients.

Note:

A suitable combination of column length (30m or 60m), diameter and temperature programme shall be selected such that compounds in the sample and the markers elute in the order of their increasing boiling points. A column length of 60m may be used to improve the elution order for the slightly polar column type.

Oven:
- Oven initial temperature: *between 40 and 100°C*
- Isothermal holding time: *between 2 and 5 min*
- Heating rate: *between 3 and 20°C/min*
- Oven final temperature: *between 280 and 325°C*
- Isothermal holding time: *>2min*
- Flow in the column: *between 1 and 2 ml/min*
Detector:
- Identification by mass spectrometer
- Quantification by flame ionization detector (FID)
- FID detector temperature: *Final oven temperature or higher*
Carrier gas:
- helium
Hot injection system:
- injector temperature : *between 250 and 280°C*
- injection volume: *between 1 and 2 µl*
Calibration:
- the preferred internal standard for quantification of SVOC peaks shall be n-tetradecane (n-C14)
- an alternative internal standard, 1,2-diethoxyethane (also named ethylene glycol diethyl ether) can be used in order to achieve improved recovery values when analysing water-based paints.

Note:

If the calibration procedures are run in an appropriate manner the selection of the internal standard should have no impact on the test result. However, it is important to ensure that the internal standard does not overlap or hide any peaks arising from the sample itself. It must therefore show a complete separation from other peaks in the chromatogram. A large choice of internal standards is thus possible but internal standards having very low boiling points (e.g. acetone…) or very high boiling points (C22 and more…) must be excluded to avoid any discriminatory phenomenon in the injector.

- All SVOCs shall be identified as far as achievable, and then quantification shall be performed with their authentic calibration standards, as specified for VOCs in ISO 11890-2, or via their relative response factors.

- Remaining unknown SVOC peaks shall be quantified using the response factor of diethyl adipate, expressed in diethyl adipate equivalents.

During the validity period of the criteria it is likely that ISO 11890-2 will be revised and its scope extended to also provide a test method for SVOC's. This guidance shall therefore be used in the interim until the standard is revised.

Annex 4. Exempted compounds

- methane;
- ethane;
- methylene chloride (dichloromethane);
- 1,1,1-trichloroethane (methyl chloroform);
- 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113);
- trichlorofluoromethane (CFC-11);
- dichlorodifluoromethane (CFC-12);
- chlorodifluoromethane (HCFC-22);
- trifluoromethane (HFC-23);
- 1,2-dichloro 1,1,2,2-tetrafluoroethane (CFC-114);
- chloropentafluoroethane (CFC-115);
- 1,1,1-trifluoro 2,2-dichloroethane (HCFC-123);
- 1,1,1,2-tetrafluoroethane (HFC-134a);
- 1,1-dichloro 1-fluoroethane (HCFC-141b);
- 1-chloro 1,1-difluoroethane (HCFC-142b);
- 2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124);
- pentafluoroethane (HFC-125);
- 1,1,2,2-tetrafluoroethane (HFC-134);
- 1,1,1-trifluoroethane (HFC-143a);
- 1,1-difluoroethane (HFC-152a);
- parachlorobenzotrifluoride (PCBTF);
- cyclic,
- branched, or linear completely methylated siloxanes;
- acetone;
- perchloroethylene (tetrachloroethylene);
- 3,3-dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca);
- 1,3-dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb);
- 1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC 43-10mee);
- difluoromethane (HFC-32);
- ethylfluoride (HFC-161);
- 1,1,1,3,3,3-hexafluoropropane (HFC-236fa);
- 1,1,2,2,3-pentafluoropropane (HFC-245ca);
- 1,1,2,3,3-pentafluoropropane (HFC-245ea);
- 1,1,1,2,3-pentafluoropropane (HFC-245eb);
- 1,1,1,3,3-pentafluoropropane (HFC-245fa);
- 1,1,1,2,3,3-hexafluoropropane (HFC-236ea);
- 1,1,1,3,3-pentafluorobutane (HFC-365mfc);
- chlorofluoromethane (HCFC-31);
- 1 chloro-1-fluoroethane (HCFC-151a);
- 1,2-dichloro-1,1,2-trifluoroethane (HCFC-123a);
- 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy-butane ($C_4F_9OCH_3$ or HFE-7100);
- 2-(difluoromethoxymethyl)-1,1,1,2,3,3,3-heptafluoropropane ($(CF_3)_2CFCF_2OCH_3$);
- 1-ethoxy-1,1,2,2,3,3,4,4,4-nonafluorobutane ($C_4F_9OC_2H_5$ or HFE-7200);
- 2-(ethoxydifluoromethyl)-1,1,1,2,3,3,3-heptafluoropropane ($(CF_3)_2CFCF_2OC_2H_5$);
- methyl acetate; 1,1,1,2,2,3,3-heptafluoro-3-methoxy-propane (n-C3F7OCH3, HFE-7000);
- 3-ethoxy- 1,1,1,2,3,4,4,5,5,6,6,6-dodecafluoro-2-(trifluoromethyl) hexane (HFE-7500);
- 1,1,1,2,3,3,3-heptafluoropropane (HFC 227ea);
- methyl formate (HCOOCH3);
- 1,1,1,2,2,3,4,5,5,5-decafluoro-3-methoxy-4-trifluoromethyl-pentane (HFE-7300);
- propylene carbonate;
- dimethyl carbonate;
- *trans*-1,3,3,3-tetrafluoropropene;
- HCF_2OCF_2H (HFE-134);
- $HCF_2OCF_2OCF_2H$ (HFE-236cal2);
- $HCF_2OCF_2CF_2OCF_2H$ (HFE-338pcc13);

- $HCF_2OCF_2OCF_2CF_2OCF_2H$ (H-Galden 1040x or H-Galden ZT 130 (or 150 or 180));
- *trans* 1-chloro-3,3,3-trifluoroprop-1-ene;
- 2,3,3,3-tetrafluoropropene;
- 2-amino-2-methyl-1-propanol;
- etyl acetate;
- butyl acetate
- and perfluorocarbon compounds which fall into these classes:
    - Cyclic, branched, or linear, completely fluorinated alkanes;
    - Cyclic, branched, or linear, completely fluorinated ethers with no unsaturations;
    - Cyclic, branched, or linear, completely fluorinated tertiary amines with no unsaturations; and
    - Sulfur containing perfluorocarbons with no unsaturations and with sulfur bonds only to carbon and fluorine.

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