Framework Contract No ECHA/2008/2 - Reference Number ECHA/2008/2/SR25

Service Request on Providing Actual Data on the European Market, Uses and Releases/Exposures for Lead Chromate

Final Report

prepared for

the European Chemicals Agency (ECHA)

RPA

July 2010

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European Chemicals Agency (ECHA)

by

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EXECUTIVE SUMMARY

Introduction

Lead chromate was identified as a Substance of Very High Concern (SVHC) according to Article 57(a) and (c) as it is classified according to Annex VI, part 3, Table 3.2 of Regulation (EC) No 1272/2008 as a carcinogen category 2, R45 (may cause cancer), and as toxic to reproduction category 1, R61 (may cause harm to the unborn child), and was therefore included in the candidate list for authorisation on 13 January 2010, following ECHA's decision ED/68/2009. This is a technical report prepared by the DHI consortium with RPA acting as the leading partner and TNO playing a supporting role on the manufacture, uses and releases of lead chromate in the EU. The aim of the report is to support the prioritisation of the substance.

Manufacture, Imports and Exports

According to the Slovenian authorities, in Slovenia, 111 tonnes of lead chromate were manufactured in 2007, with the volume having steadily increased since 2002, but declined to 51t in 2008 (Slovenia, 2010 in Technical report, 2010). However, there is significant uncertainty whether the tonnages provided reflect production of the substance under consideration. Consultation with several pigments manufacturers indicate that a manufacturer of lead chromate does not exist anymore in France. No additional information through literature search has been found regarding manufacture at European level, nor via further consultation.

Information submitted by one non-EU company suggests that lead chromate is imported into the EU in the form of a pigment in fairly substantial quantities, which are in the range of 100 – 1,000 t/y. Import of occasional very low amounts of crocoite (few kg per year and not every year), for distribution in the art conservation field, was reported by one company. Some information is available from the Slovenian authorities (29 tonnes imported in 2009) but it is unclear if this refers to lead chromate imported from non-EU countries. Lead chromate may be imported as part of imports of formulations, such as paints. Information submitted by the Lithuanian Environmental Protection Agency indicates imports of lead chromate paints from countries such as Ukraine and Belarus. The amount of lead chromate contained in the imported paints in 2008 was below 1 tonne.

Information on exports from the EU is not available; however, it is unlikely to be substantial, if any at all.

Uses

The uses identified include:

- **use as a pigment in paint manufacture**: literature suggests that lead chromates have been used in pigments in anti-corrosive primer paints and powder coatings. Safety Data Sheets identified online include products such as polyurethane lacquers, enamels for use in the field of agricultural machinery, carpentry, sheet metal work, and maintenance of industrial equipment, road marking paints, vehicle refinishing paints, foundry pattern paints, powder coatings , and

screen printing inks. Many of these have now been reformulated and are not produced and marketed any more.

The European Council of the Paint, Printing Ink and Artists' Colours (CEPE) estimates that lead chromate was used in 2008/2009 in paints for vehicle refinishing (vintage cars, commercial vehicles, trucks and busses, etc.), farming material, civil engineering material, boats/ships, road sign and road marking, and general industrial including e.g. camouflage and ammunition marking, skips, plant & machinery. CEPE estimates that the consumption of lead chromate in such paints exceeds 100 t/y. Synthetic lead chromate may be used as pigment in artists' colours for art conservation applications; one company supplies paints for conservation to 300 customers across the EU (the amount of lead chromate used in such paints is at the kilogram level). Quantified information on specific EU Member States is available for France (50 tonnes in 2005), Sweden (3.5 tonnes in 2004) and Slovenia (0.4 tonnes in 2009 but 4.97 tonnes in 2008).

There is considerable confusion not only among distributors and downstream users of paints but also among paint manufacturers themselves with regard to the identity of the lead pigments present in their products. On several occasions, it proved to be the case that the term "lead chromate" was loosely used to describe any lead chromate pigment of a yellow/orange colour and in reality, the pigment used is typically C.I. Pigment Yellow 34 or C.I. Pigment Red 104. Eurocolor has confirmed that members of the European Manufacturers of Lead Chromate and Lead Molybdate Pigments (EMLC) do not market lead chromate. According to information provided by a non-EU manufacturer of pigments, lead chromate is not used as a pigment due to its poor colour stability;

- **use as a pigment in plastic masterbatch**: a non-EU based company has provided information on its sales of lead chromate to EU masterbatch producers which are in the 100-1,000 t/y range. Masterbatch may contain 40% of lead chromate, the final plastic articles may only contain 0.5-1% of the substance. Some additional information was provided by the Slovenian authorities; consumption of lead chromate in masterbatch was 0.585 tonnes in 2009;

- **use in the manufacture of pyrotechnics**: lead chromate may be used in pyrotechnic delay compositions for ammunition, ignition compositions for ammunition, delay detonators for the mining and demolition sectors. The concentration of lead chromate in a detonator could be as low as <0.1%, according to Safety Data Sheet. Three companies located in two countries have been identified still using lead chromate in relatively low tonnages. Chromates are apparently in the process of being replaced; the European Federation of Explosive Manufacturers has argued that detonator delay compositions have been modified some years ago to avoid lead;

- **use as a pigment in leather finishing and wood impregnation mixtures**: some Safety Data Sheets suggest that lead chromate may be used as a pigment in water-based leather finishing products at a concentration of up to 33%. The Slovenian authorities have also suggested that lead chromate may be present in wood impregnation products (described as "industrial bark-liquors"); only small quantities of lead chromate are consumed (0.002 tonnes in 2009); and

- **use as a reference material in art conservation**: lead chromate (as the mineral crocoite) may be sold to conservation agencies as a reference material. The material is imported by at least one company in small quantities, at the kilogram level. Synthetic lead chromate may also be used as a reference material.

A number of additional uses have also been suggested as relevant; however, this has not been confirmed. Such uses include:

- **manufacture of other pigments**: one non-EU manufacturer of lead pigments suggests that there is a possibility that lead chromate is produced or imported into the EU for the purpose of manufacturing C.I. Pigment Yellow 34 or C.I. Pigment Red 104;

- **use in detergents**: referenced in the literature and reported by INRS (Annex XV dossier), but considered by the International Associations for Soaps, Detergents and Maintenance Products as wrongly reported, phased out, or potentially a "niche" use, not known to its members;

- **use in embalming products**: although theoretically it can be used in spray skin restorative products and green cosmetic powder, actual use is quite unlikely; no embalmer in EU uses products containing lead chromate and there are plenty of lead chromate-free alternatives according to the European Association of Embalmers;

- **use in tattoo inks**: although this is referenced in literature, the Tattoo Ink Manufacturers of Europe has argued that lead chromate is not used in tattoo and permanent make-up inks worldwide;

- **use in photosensitive materials**: suggested in the Annex XV dossier but not confirmed in literature; and

- **other uses**: uses such as in printing fabrics, rubber, decorating porcelain and analytical chemistry have not been confirmed.

Releases from Manufacture and Use

Manufacture: no information on releases and exposure is available.

Uses: generally, limited information is available. This can be summarised as follows:

- **use in the manufacture of paints**: information from one company manufacturing small quantities of art conservation paints indicated no releases to air, water or soil and only a very small loss (0.1% of the amount used in the manufacture of the paints) to waste.

  No information is available on worker exposure during this application;

- **use of lead chromate-containing paints**: some information is available on releases of lead chromate from use of paints in military and civilian applications. This suggests that small releases to air and waste are possible; no releases to soil or water appear to occur.

  With regard to occupational exposure during the application of paints, some confidential information was made available by consultees. Our own estimates (based on the Advanced REACH Tool and ECETOC TRA) suggest that the reasonable worst-case level of inhalation exposure when using appropriate respiratory protection would be 0.75 mg/m^3. For dermal exposure, the use of protective gloves would result in an exposure of 300 mg;

- **handling of mineral crocoite**: during the handling of crocoite in the manufacture of pigments and paints for art conservation a loss of 1.25-2.5% of the amount used in the form of waste may arise;

- **use in the manufacture of pyrotechnics**: for one company using lead chromate in delay and ignition compositions, a small percentage is lost to air as well as in the form of waste. Another company has claimed that there are no releases to any compartment during the use of the substance. If any waste arises, due to its pyrotechnic it is destroyed by combustion which generally gives lead and chrome oxide. Afterwards, the solid combustion products are treated as special waste.

  With regard to occupational exposure during the manufacture of pyrotechnics, confidential information from two companies indicates that worker exposure to lead chromate is very low, if any;

- **detonation of explosives**: consultation with companies and explosives experts indicates that lead chromate should be completely reacted when the detonation takes place with the formation of lead (II) oxide and chromium (III) oxide;

- **use in manufacture of other paint chromate pigments**: as explained earlier in this Summary, there is a possibility that lead chromate is used in the manufacture of other lead chromate pigments. We did not obtain specific information on this but we estimated the likely worker inhalation and dermal exposure from such a use via the Advanced REACH Tool and ECETOC TRA. For inhalation exposure, the reasonable worst-case estimate for dumping is 0.49 mg/m^3 and for vacuum transfer is 0.015 mg/m^3. For dermal exposure, the respective reasonable worst case estimates are 0.96 mg (with LEV), 96 mg (without LEV), and 4.8 mg (with LEV) and 48 mg (without LEV) when protective gloves are used; and

- **education uses**: in the past lead chromate may have been produced in educational establishments by the addition of potassium chromate solution to a lead nitrate solution. The total amount produced per school might have added up to 3 g per school. Currently, this combined amount will be collected and disposed by a licensed waste disposal contractor.

GLOSSARY

Term	Description
ART	The Advanced REACH Tool (ART) version 1.0 incorporates a mechanistic model of inhalation exposure and a statistical facility to update the estimates with the user's own data. This combination of model estimates and data produces more refined estimates of exposure and reduced uncertainty. The ART project has been conducted in close collaboration with a range of stakeholders from industry and member states. The use of ART for workers exposure assessment under REACH is described in ECHA' updated Guidance on Information Requirements and chemical safety assessment (see http://www.advancedreachtool.com/)
Balsa	Strong lightweight wood of the balsa tree used especially for floats
CN8	Top 8-digit code of the Combined Nomenclature (CN) product classification
Crocoite	A mineral consisting of lead chromate, PbCrO4, and crystallizing in the monoclinic crystal system
Delay composition	A pyrotechnic composition, a sort of pyrotechnic initiator, a mixture of oxidizer and fuel that burns in a slow, constant rate that should not be significantly dependent on temperature and pressure. Delay compositions are used to introduce a delay into the firing train, e.g. to properly sequence firing of fireworks, to delay firing of ejection charges in e.g. model rockets, or to introduce a few seconds of time between triggering a hand grenade and its explosion. Typical delay times range between several milliseconds and several seconds
Detonator	A device used to trigger an explosive device. Detonators can be chemically, mechanically, or electrically initiated, the latter two being the most common
ECETOC TRA	ECETOC Targeted Risk Assessment Tool (see http://www.ecetoc.org/tra)
Embalming	The art and science of temporarily preserving human remains to forestall decomposition and to make them suitable for display at a funeral
Enamel	An opaque, glassy coating baked onto metal or ceramic objects; a coating that dries to a hard, glossy finish
Foundry pattern	Every casting that a foundry makes needs a pattern whether that is resin, metal or wood. Wood patterns are constructed from either Yellow Pine or Mahogany in the UK and these need protecting from the chemicals used to bond the sand mould and abrasion. In some countries the colour of this paint is also used to indicate what metal is going to be cast using this pattern e.g. Red is Cast Iron, Blue is Steel. The paint will also protect the pattern while it is in storage
Gelcoat	A combination of resin and pigment that comprises the smooth outside coating of, for instance, a fibreglass boat
Igniter	A pyrotechnic initiator (also initiator or igniter) is a device containing a pyrotechnic composition used primarily to ignite other, more difficult-to-ignite materials, e.g. thermites, gas generators, and solid-fuel rockets. The name is often used also for the compositions themselves
Lacquer	A clear or coloured varnish that dries by solvent evaporation and often a curing process as well that produces a hard, durable finish, in any sheen level from ultra matte to high gloss and that can be further polished as required
Masterbatch	A pelletized plastic material containing highly loaded pigments which is used in a polymer system to change the final colour and/or properties of a plastic part
PC	Polycarbonate
PMMA	Poly(methyl methacrylate) (a transparent thermoplastic)
Primer paint	A preparatory coating put on materials before painting. Priming ensures better adhesion of paint to the surface, increases paint durability, and provides additional protection for the material being painted
PVC	Polyvinyl chloride
Pyrotechnics	Mixtures of finely divided fuels and oxidizer powders, which may include various organic binders and colour intensifiers, used to produce sound, light, heat, smoke, delay, and gas
RISKOFDERM	Risk Assessment of Occupational Dermal Exposure to Chemicals (model)

Term	Description
Screen printing	A printing technique that uses a woven mesh to support an ink-blocking stencil. The attached stencil forms open areas of mesh that transfer ink as a sharp-edged image onto a substrate. Commonly used to print on clothing and signs
Skin restorative	Material used to mask skin and tissue damage which is may be used by embalmers
Thermoplastic coating	A plastic coating that softens when it's heated and hardens again once it cools down
Topcoat paint	The final coating film or multiple layers of the same coating film applied to the surface. This can be the coat holding the preferred colour it is the last paint to be applied to a surface. Usually applied over a primer, undercoater, or surfacer; also known as finish coat
Touch-up painting	Applying small amounts of paint or stain to cover pre-existing blemishes

1. INTRODUCTION

1.1 Objectives

In the framework of the authorisation process, Member States Competent Authorities or the European Chemicals Agency (ECHA), on a request by the Commission, may prepare Annex XV dossiers for the identification of substances of very high concern (SVHC). An Annex XV dossier has been prepared for lead chromate by France (dated August 2009). The dossier concludes that lead chromate is a carcinogenic, mutagenic and reprotoxic (CMR) substance. It has, therefore, been put forward for consideration as a SVHC and potentially, subsequent inclusion in Annex XIV of the REACH Regulation.

The main objective of the project has been to provide background information on the markets, uses and releases of lead chromate, with the aim to support priority setting of the substance on the candidate list for inclusion in Annex XIV.

The emphasis of this analysis is on uses other than those where the substance is an intermediate as well as on those uses that potentially result in significant releases and exposure.

1.2 Methods

In undertaking this study, RPA conducted a desk-based review of literature as well as direct consultation with industry stakeholders. A dedicated web page was created within the RPA Internet site (http://www.rpaltd.co.uk/news-dnt.shtml) where a description of the project was provided as well as a link to a questionnaire in Microsoft Word format. Consultation encompassed manufacturers and users of the substance identified through literature review and Internet searches. Information was sought from:

- manufacturers of the substance;
- distributors and importers of the substance as well as of mixtures or articles that may contain it; and
- potential users of lead chromate such as manufacturers of pigments and paints, manufacturers of explosives and pyrotechnics, manufacturers of plastic masterbatches, manufacturers of dentistry products, embalmers and manufacturers of products for the embalming industry and manufacturers of tattoo inks.

We also contacted a series of trade associations relevant to the stakeholders mentioned above as well as a number of national authorities responsible for the safe handling of explosives and ammunition. It should also be noted that ECHA supported this consultation exercise by directly contacting those companies that have pre-registered the substance.

Finally, a second questionnaire was also formulated and used for consultation with Competent Authorities in the EU/EEA. This was disseminated by ECHA and responses were returned directly to RPA. Only a small number of Member State authorities made an input to this study.

2. NAME AND OTHER IDENTIFIERS OF THE SUBSTANCE

Lead chromate can be identified as follows:

Substance Name:	Lead chromate
EC Number:	231-846-0
CAS Number:	7758-97-6
IUPAC Name:	Lead(2+) chromate

The Annex XV dossier for the substance notes that CAS Numbers 8049-64-7 and 181768-98-9 have been deleted from the CA index, but may still be in use.

It is important to also note that this substance is different to lead sulfochromate yellow (C.I. Pigment Yellow 34, EC Number 215-693-7, CAS Number 1344-37-2) or lead chromate molybdate sulphate red (C.I. Pigment Red 104, EC Number 235-759-9, CAS Number 12656-85-8) which are (incorrectly) frequently described as 'lead chromate'.

In the course of the study, we found numerous examples where this confusion occurs. A company (company **LEAD 1**)[1] that claims to be a leading global manufacturer of pigments has highlighted this issue and confirmed its experience that users of C.I. Pigment Yellow 34 and C.I. Pigment Red 104 may use the term 'lead chromate' as a shorthand name for these commercially sold pigments. Technical and Safety Data Sheets may also add to this confusion by using incorrect descriptions or erroneous CAS/EC numbers.

[1] For confidentiality reasons, companies are referred to by codenames in this report.

3. INFORMATION ON MANUFACTURE, IMPORT, EXPORT AND RELEASES FROM MANUFACTURE

3.1 Production Process

Literature: according to the Annex XV dossier for the substance, lead chromate occurs in nature as crocoite, an orange-red mineral. Lead chromate can also be produced by reacting sodium chromate with lead nitrate, or by reacting lead monoxide with chromic acid solution.

Consultation: no additional information was obtained during the present study.

3.2 Production Sites

Literature: no information has been found in literature. The Annex XV dossier for the substance provides very little information in this regard.

Consultation: we have not conclusively identified any company based in the EU that manufactures the substance. Information from the Slovenian authorities (Chemicals Office of the Republic of Slovenia, 2010) suggests that the substance has been produced in the country between 2002 and 2008 in quantities between 43 and 111 tonnes. This upper limit was reached in 2007. Since then, production volumes declined with the 2008 production tonnage having been just over 51 tonnes. When additional information was obtained on the identities of the potential manufacturers, the suggested companies appeared to include manufacturers of paints and sealants/adhesives, i.e. companies which would most likely be users of the substance. It is therefore uncertain that manufacture of the substance indeed takes place in the country. **Table 3.1** provides the manufacture, import and consumption tonnages for lead chromate in Slovenia for the years 2002-2009. What is immediately evident is the considerable tonnage difference between manufacture and consumption. In addition, the imported tonnage jumped significantly between 2008 and 2009 without an analogous increase in the consumption.

Table 3.1: Assumed Manufacture, Imports and Consumption of Lead Chromate in Slovenia

Year	Manufacture (t)	Imports (t)	Consumption (t)
2002	43.1	0.83	9.76
2003	56.72	2.64	10.69
2004	71.47	1.58	14.58
2005	65.39	2.85	14.23
2006	92.87	2.39	13.22
2007	111.23	2.16	10.70
2008	51.2	0.33	3.56
2009	?	29.32	4.05

Source: Chemicals Office of the Republic of Slovenia (2010)

In the course of the study, we received communication from the lead registrant (company **LEAD 2**) for the SIEF of two other lead chromate pigments, lead sulforchromate yellow (C.I. Pigment Yellow 34) and lead chromate molybdate sulphate red (C.I. Pigment Red 104). The company suggested that a large EU-based manufacturer (company **LEAD 3**) was manufacturing and marketing the substance in the past. Following the company's takeover by the lead registrant company (**LEAD 2**) and the cessation of production of lead chromate, it is argued that the substance may be only produced and marketed outside Europe by other manufacturers. None of the current EU-based manufacturers of C.I. Pigment Yellow 34 and C.I. Pigment Red 104 manufactures lead chromate. Company **LEAD 1** has also argued that it is highly unlikely that the substance is manufactured or sold in Europe in significant quantities.

Company **LEAD 4** was suggested as a potential manufacturer and indeed the substance appears to be on the company's online product catalogue. We contacted the company and we established that it only acts as a distributor supplying small quantities of the substance. In fact, it is uncertain that the substance supplied by the company is actually lead chromate. Company **LEAD 5** suggested that company **LEAD 28** is one of its suppliers. However, company **LEAD 28** confirmed to us that it only supplies C.I. Pigment Yellow 34.

Another company (company **LEAD 5**) that was contacted as a possible manufacturer of lead chromates confirmed it does not produce or import lead chromate.

Conclusion: the available evidence suggests that manufacture of lead chromate within the EU, at least in significant quantities, is very unlikely but cannot be categorically precluded. As will be discussed later in this report, the use of the substance is accordingly limited, especially when compared to lead sulfochromate yellow and lead chromate molybdate sulphate red.

3.3 Production Volumes

Literature: no information has been retrieved.

Consultation: we did not obtain specific information on production tonnages within the EU. It is clear that any tonnage still manufactured within the EU should be expected to be small (see discussion in Section 3.2 above).

3.4 Imports into the EU

Literature: we have explored the external trade statistics provided by Eurostat[2]. There are three specific CN8 codes that relate to chromium pigments for the tanning/leather industry:

[2] Available here: http://epp.eurostat.ec.europa.eu/portal/page/portal/external_trade/data/database.

- 32062000 - chromium pigments;
- 32062010 - chromium pigments with ≥ 85% wt. lead chromate; and
- 32062090 - chromium pigments with <85% wt. lead chromate.

Tonnage information is available only for the first category (chromium pigments). Imports into the EU from non-EU countries declined between 2005 and 2009 from 5,577 tonnes to 2,851 tonnes. Exports from EU-27 to non-EU countries were higher at 10,984 - 6,293 tonnes between 2005 and 2009. However, we cannot be certain whether and to what extent these tonnages include lead chromate under CAS number 7758-97-6.

Consultation: we identified one company (company **LEAD 6**) that imports a small amount of crocoite from outside the EU for distribution in the art conservation field. The material imported amounts to a few kilograms per year and imports do not take place every year.

Lead chromate is also imported as a pigment stabilised with silica in fairly substantial quantities (in the 100-1,000 t/y range), according to information submitted by a non-EU company (company **LEAD 7**). This information is presented in more detail in the Confidential Annex 2.

Further, lead chromate may be imported as part of imports of formulations, such as paints. Information submitted by the Lithuanian Environmental Protection Agency (2010) indicates imports of lead chromate paints from countries such as Ukraine and Belarus. From Ukraine, six different products were imported in 2006 at a total tonnage of 28.1 tonnes. With a lead chromate concentration of 0.5-5%, the amount of lead chromate imported was 0.14-1.4 tonnes. The consumption of seven of these products in 2008 (latest consumption data) was 6.64 tonnes (containing 0.03-0.33 tonnes of lead chromate). Import data for products imported from Belarus are not available; data for one paint product showed a consumption of 0.203 tonnes in 2008 (containing 2×10^{-4} tonnes of lead chromate); for a second product, consumption in 2008 was 7.654 tonnes and in 2009 was 3.6 tonnes (containing 0.001 and 0.0005 tonnes of lead chromate respectively). Efforts to contact the manufacturers located in Ukraine and Belarus were not fruitful, hence we have not been able to confirm whether the pigment contained in these products is indeed lead chromate or another substance (e.g. C.I. Pigment Yellow 34).

We have also attempted to contact a substantial number of potential manufacturers and suppliers of chromates (pigments) in countries such as China, India, the USA and a number of potential EU distributors. No significant information was collected; only one company (**LEAD 29** based in the USA) confirmed the manufacture of lead chromate outside the EU but noted that it does not directly export the substance to EU customers.

Conclusion: later in this report, we discuss the possibilities for lead chromate applications in the EU with paint and plastic masterbatch manufacture probably being the most important ones. Given the apparently limited, if any at all, manufacture of lead chromate in the EU, it is reasonable to expect that the substance is imported into the EU. Unfortunately, no quantified information on imports is available.

3.5 Future Trends

No specific information is available.

4. INFORMATION ON USES OF LEAD CHROMATE

4.1 Use in the Manufacture of Paints

4.1.1 Description of Use

Literature: according to the literature, due to their special properties, various chromate pigments, including lead chromate, have been used in anti-corrosive primer paints. Although primarily used in wet paints, chromate pigments may also be used in powder coating applications. Lead chromates have primarily been used in topcoat paints, but they may also be added to primer paints to provide colouring (HSE, 1999). As well as giving the paint its tint, lead pigments are highly opaque, so that a relatively small amount of the compound can cover a large area (RSC, 2007).

KemI (2007) mentions that lead chromate is used in car touch-up paints as a pigment in yellow and orange paints where it is not been possible to develop alternatives with the same shade of colour and coverage; Car Repair 1950 (undated) notes that medium chrome yellow car repair enamels is 100% lead chromate). Lead chromate may have also been present in paints used on farm machinery (Culpin, 2008).

We have identified Safety Data Sheets for several paint products that apparently contain lead chromate. However, through detailed research and consultation with relevant companies we have established that many of the products identified are no longer used or incorrectly indicate that lead chromate is among their components. Examples of products identified include:

- polyurethane lacquers with a lead chromate concentration of 25-50% (Comptoirs Industriels du Rhone, 2005) – this product is confirmed to be no longer sold;
- enamels for use in the field of agricultural machinery, carpentry, sheet metal work, maintenance of industrial equipment with a lead chromate concentration of 0.5-5% (Langcolor, 2006; Langcolor, undated) – this product has been confirmed not to contain lead chromate with CAS No 7758-97-6;
- road marking paints (including thermoplastics) with a lead chromate concentration of 1-20% (Zep Belgium, 2008; Kestrel Thermoplastics, 2002) – it is unclear whether this product is still sold;
- vehicle refinishing paints with a lead chromate concentration of 35-45% (Spies Hecker, 2008) – a distributor of this product (a concentrate, hence the high lead chromate levels) confirms that it supplies small quantities of this product;
- foundry pattern paints for wood patterns used in the foundry industry with a lead chromate concentration of 10-20% (John Burn, 1998) - consultation with the company marketing this product suggests that the product has now been reformulated and no longer contains lead chromate;

- powder coatings with a lead chromate concentration of 0.5-25% (Dupont Powder Coatings, 1999) – this product is no longer available; and

- screen printing inks in the form of solutions of saturated polyester resins in organic solvents (Proell, 2004; Proell, 2004b). Two such products were identified with a lead chromate content of 2.5-10%. One is a product that was used on plastics, especially on PVC, PMMA and PC. Typical applications are PC-films printed with the ink, which are used for dials for speedometers. Another product has been used on metals, polyester, PC or coated metals. A typical application was the manufacture of membrane switches. Communication with the manufacturer has revealed that these products stopped being produced in 1994.

A common pattern that emerged during research and consultation with relevant companies is that there is considerable confusion not only among distributors and downstream users of paints but also among paint manufacturers themselves as regards the identity of the lead pigments present in their products. On several occasions, it proved to be the case that the term "lead chromate" was loosely used to describe any lead chromate pigment of a yellow/orange colour and in reality, the pigment used is typically C.I. Pigment Yellow 34 or C.I. Pigment Red 104. Other products may simply not be on the market any more or may have been reformulated and no longer contain lead chromate.

Past consultation: the European Council of the Paint, Printing Ink and Artists' Colours (CEPE) provided comments to the Annex XV dossiers that were prepared for the three lead chromates. Among those, data on the use of lead chromate in paints in the EU in 2008/2009 were included. CEPE estimated that lead chromate was used in (CEPE, 2009):

- vehicle refinishing (vintage cars, commercial vehicles, trucks and busses, etc.);
- farming material;
- civil engineering material;
- boats/ships;
- road sign and road marking paints; and
- general industrial including e.g. camouflage and ammunition marking, skips, plant & machinery.

For all these areas, the use of lead chromate was characterised as "small", with the exception of vehicle refinishing where use was characterised as "medium".

The CEPE survey was conducted in September 2009 and it relates to uses and volumes in 2008/2009. The information on uses is considered by CEPE to be reliable – companies were asked to provide tonnage information for lead chromate, C.I. Pigment Yellow 34 and C.I. Pigment Red 104, therefore the companies had the opportunity to provide a clear distinction between the usage of each of the three pigments (CEPE, 2010).

It is worth noting that CEPE consulted its members in relation to the present study and it was agreed that CEPE would not contribute to a detailed data collection to support the use of lead chromate pigments; individual members of CEPE might "*elect to prove in co-*

operation with the suppliers of lead chromate pigments that there are negligible exposure and emissions" (CEPE, 2010).

Current consultation: the information collected from paint manufacturers was very limited. One company (company **LEAD 9**) which confirmed its current consumption of lead chromate declined to provide information suggesting that it had provided all available information to CEPE for the survey that was undertaken in 2009.

Information has also been collected from a company (company **LEAD 11**) which uses lead chromate in paints for military use as well as from company **LEAD 12** that uses lead chromate paints on military and civilian equipment. The information that has been provided is commercially sensitive and is thus presented in the Confidential Annex 2.

With regard to vehicle refinishing, one company (company **LEAD 13**) indicated that it manufactures paints that contain lead chromate but these are only sold outside the EU; the company plans to move production to a non-EU country. Another company (company **LEAD 14**) indicated that it supplies lead chromate-containing 'tinting colours' (i.e. concentrate) which are mixed with other tinting colours according to a recipe and used for coating/repairing commercial vehicles. The quantities involved are very low with fewer than 100 litres being sold in Denmark in 2009. The manufacturer of these paints (company **LEAD 15**) declined to provide any additional information.

Synthetic lead chromate may be used as a pigment in artists' colours for art conservation applications. The concentration of lead chromate in such products may range between a few per cent up to 70%, according to company **LEAD 6**. These are usually sold in small quantities in jars of 3 ml.

Consultation with companies has further confirmed the confusion in relation to the identities of different lead chromate pigments. Company **LEAD 10** originally suggested that it places a variety of paint formulations that contain lead chromate on the market. Indeed, a downstream user was also identified and the user originally confirmed that the pigment contained in the product used is lead chromate. However, upon closer inspection, the manufacturer revised the information submitted and clarified that the pigments used are C.I. Pigment Yellow 34 and C.I. Pigment Red 104.

Of interest is the information that a paint manufacturer (company **LEAD 8**) provided to the study team. The company contacted its supplier of lead chromate and was advised that, historically, there have been several CAS numbers issued to 'lead chromates' over the years, due to slightly different modifications. The level of soluble lead has also affected the classification of the product. The grades that the company currently buys in are considered to be ca. 95% lead chromate (CAS No 7758-97-6) and below 5% soluble lead. Although further clarification was sought, it was not made available before the completion of this report.

In relation to consultation with EU/EEA countries' national authorities, information was provided by the Latvian Environment, Geology and Meteorology Centre (2010) and the Lithuanian Environmental Protection Agency (2010). Limited confidential information

was provided by the Norwegian Climate and Pollution Agency (2010) – this is presented in the Confidential Annex 2. The Chemicals Office of the Republic of Slovenia (2010) provided detailed information on specific lead chromate-based paint products marketed in the country and this is summarised below. Finally, some information on pigments imported and used in Cyprus, which was provided by the Cypriot Department of Labour Inspection (2010) proved to relate to other lead chromate pigments rather than the substance of concern.

Role of lead chromate in paints: we have enquired among consultees as to whether lead chromate not only provides colour but also acts as a corrosion inhibitor. Responses from company **LEAD 10** and the Norwegian authorities indicate that lead chromate only acts as a pigment.

Conclusion: information collected by CEPE would suggest that lead chromate finds some use as a pigment in paint manufacture. However, our experience with consulting with manufacturers and users of lead chromate paints makes us cautious in considering claims of ongoing use of the substance. It is reasonable to expect that the use of lead chromate may be more limited than what is implied by some stakeholders.

4.1.2 Locations and Quantities Used

According to the CEPE survey of 2009, the estimated tonnage of lead chromate used in paints sold in the EU was above100 tonnes in 2008 (CEPE, 2009). Nevertheless, it should be noted that the volumes were obtained by extrapolation from a small number of responses and they are only rough estimates. CEPE had received around 30 to 40 positive responses (companies that are using any of the three lead chromate pigments companies were consulted upon). CEPE did not provide information on the locations of companies that still use lead chromate in their paint products.

A single manufacturer of paints for conservation purposes (company **LEAD 6**) has indicated that paints for conservation may be sold to 300 customers across the EU. The amount of lead chromate used in such paints is at the kilogram level.

Quantified information on specific EU Member States is available for:

- **France**: INRS (2005) suggests a consumption of pure lead chromate in France of about 50 tonnes in 2005;

- **Lithuania**: in 2004, just over 2 tonnes of paints containing lead chromate were consumed after being imported from Spain. These had a concentration of lead chromate of 1-2.5% bringing the consumption of the substance itself to 0.02-0.05 tonnes that year. After 2004, imports into Lithuania from other EU countries are not filed under the 'imports' heading and thus data are not available. There is some further information on paints that were imported from Ukraine and Belarus. A summary of the relevant tonnage was provided in Section 3.4. Additional detail of the relevant products are provided in the Confidential Annex 2;

- **Sweden**: according to KemI (2007), the use of lead chromate fell sharply in Sweden, from 76 tonnes in 1992 to 3.5 tonnes in 2004;

- **Slovenia**: several products that contain lead chromate have been available on the Slovenian market, according to the Chemicals Office of the Republic of Slovenia (2010). The available information on annual consumption of the substance (not the mixtures) per product type is presented in **Table 4.1**.

Table 4.1: Consumption of Lead Chromate Paints in Slovenia in 2002-2009 (tonnes/year)

Year	Lead chromate consumption								
	Varnishes for metal corrosion protection	Varnishes for the protection of furniture	Enamels for metal corrosion protection	Industrial paint for metal corrosion protection	Industrial paint for plastics	Industrial paint for marking on rubber	Resins for boat maintenance	Road marking paints	Printing inks
2002	3.062		5.984	0.384					0.228
2003	3.318		5.335	0.284	0.218		0.079		0.085
2004	4.103	0.298	5.701	0.191		0.003	0.076	0.020	0.084
2005	2.408		9.644	0.193			0.094	13.000	0.068
2006	1.358		9.730	0.004		0.001	0.083	2.000	0.055
2007	1.894		6.934	0.016	0.015		0.076	8.000	0.076
2008	1.366	0.001	3.269	0.019	0.020	0.002	0.235	0.002	0.057
2009	0.395		3.502	0.003		0.001		0.001	

Source: Chemicals Office of the Republic of Slovenia (2010)

There appears to be a general decline in consumption in recent years. Among the product categories presented in the table, enamels and varnishes for metal corrosion protection have generally been among the most popular products. Road marking paints may have seen significant sales in 2005-2007 but the latest consumption figures suggest a much more modest consumption level. It should be noted that direct consultation with the companies manufacturing, importing or distributing the relevant products in Slovenia was not possible to undertake; therefore, it is not clear if and to what extent there may be any confusion with regard to the identity of the lead pigment contained in the relevant products.

4.1.3 Structure of Supply Chain

Information of relevance to specific companies is presented in the Confidential Annex 2. We may generally assume that the number of suppliers of lead chromate to the paint making industry may be small but the number of users of these paints could be substantial. As for paints for conservation purposes, a single manufacturer has indicated that these may be sold to 300 customers across the EU, while crocoite as a reference material may

be supplied to 200 customers. Nonetheless, the amount sold per customer in the latter case is only a few grams per year.

4.1.4 Future Trends

There have been suggestions by some consultees that they are in the process of replacing lead chromate formulations. In addition, in several cases our contacts with individual companies revealed that Safety Data Sheets often refer to old products that have now been replaced. Therefore, it would be reasonable to assume that the use of lead chromate in paints is in decline.

4.2 Use in the Manufacture of Plastics

4.2.1 Description of Use

Literature: according to OECD (1994), plastic products that contain lead chromate as a pigment include:

- plastic masterbatches; and
- finished products coloured with the pigments (e.g. containers, bags, film, sheeting etc.).

Consultation: a non-EU based company (company **LEAD 7**) has provided information on its sales of lead chromate to EU masterbatch producers, which are in the 100-1,000 t/y range. Additional detail is presented in the Confidential Annex 2.

It should be noted that the content of lead chromate in the final plastic products is much lower. Information from the aforementioned company suggests that while the masterbatch may contain 40% of lead chromate, the final plastic articles may only contain 0.5-1% of the substance.

The Latvian Environment, Geology and Meteorology Centre (2010) also provided details of two masterbatch products, which apparently contain lead chromate at concentrations of 30-40% and 50-75%. These are imported into Latvia from another EU Member State. (0.23-0.315 tonnes in 2009). However, communication with company **LEAD 24,** which is the supplier of these products confirms the non-use of lead chromate. The substance was indeed used in the past but not any more.

4.2.2 Locations and Quantities Used

Limited information is available on locations of use. It is expected that several masterbatch manufacturers across the EU may potentially use the substance; the locations of the customers of the company **LEAD 7** are revealed in the Confidential Annex 2. In relation to tonnages, as discussed above, the imported tonnage is in the range of 100-1,000 t/y. Some additional detail is presented in the Confidential Annex 2.

Some information on specific products has been provided by the Chemicals Office of the Republic of Slovenia (2010). This is reproduced below. The masterbatch products consumed in Slovenia in the period 2002-2009 contained lead chromate at concentrations ranging between 14% and 65%.

Table 4.2: Consumption of Lead Chromate in Masterbatch Products in Slovenia in 2002-2009

Year	Lead chromate tonnage
2002	0.118
2003	1.882
2004	0.696
2005	2.770
2006	2.359
2007	1.832
2008	0.211
2009	0.585

Source: Chemicals Office of the Republic of Slovenia (2010)

4.2.3 Structure of Supply Chain

Given the nature of the product in question (plastic masterbatches), it is possible that a small number of suppliers of lead chromate may supply this to a modest number of masterbatch suppliers, but eventually the number of plastics manufacturers who use the coloured masterbatch may be particularly large and spread across the EU.

4.2.4 Future Trends

No information is available.

4.3 Use in the Manufacture of Pyrotechnics

4.3.1 Description of Use

Literature: it is suggested that lead chromate may be used as oxidisers in time-delay compositions ignitable by shock tubing (Rico *et al*, 2004). More generally, hexavalent chromium compounds have been widely used as oxidisers in pyrotechnic delay compositions (based on fuels such as W, Mn, B, Zr-Ni alloy, etc.) and some ignition compositions. A typical delay cartridge may contain (Valenta, 2009):

- a chromate in the pyrotechnic delay;
- potassium perchlorate in the pyrotechnic delay;
- lead styphnate in the percussion primer; and
- an ammonium perchlorate- or potassium perchlorate-based output propellant.

A number of Safety Data Sheets for detonator products that contain lead chromate have been identified online, however, they do not appear to be marketed in the EU. In those that show a concentration of lead chromate, this appears to be below 0.1% (Orica, 2008; Orica, 2008b).

Consultation: consultation undertaken for this study has suggested that lead chromate may be used in:

- pyrotechnic delay compositions for ammunition;
- ignition compositions for ammunition; and
- delay detonators for the mining and demolition sectors.

Information submitted by individual companies (companies **LEAD 11**, **LEAD 19** and **LEAD 20**) is provided in the Confidential Annex 2.

Chromates are apparently in the process of being replaced (Valenta, 2009). The European Federation of Explosive Manufacturers (2010) has argued that detonator delay compositions have been modified some years ago to avoid lead. Company **LEAD 27** also confirmed that it recently stopped using lead chromate in its detonators.

4.3.2 Locations and Quantities Used

The companies that confirmed their current use of lead chromate are located in two countries in the EU and the quantities used are small, one tonne or less – details are provided in the Confidential Annex 2. Notably, the Irish Health and Safety Authority (2010) has confirmed that the substance is not used in Ireland.

4.3.3 Structure of Supply Chain

Three EU companies have provided some information (companies **LEAD 11**, **LEAD 19** and **LEAD 20**). All three of them have a single supplier of lead chromate. All three suppliers are located in the EU and on two occasions in the same country as the manufacturer of the pyrotechnics. In relation to downstream users of the pyrotechnics, these may be located in several EU countries, some of them being national defence agencies.

4.3.4 Future Trends

It is understood that consumption patterns generally depend on customer demand. We have been advised that some of the current users of the substance may be in the process of investigating alternatives and others have already replaced lead chromate.

4.4 Use as a Pigment in Leather Finishing and Wood Impregnation Mixtures

4.4.1 Description of Use

We have identified the Safety Data Sheets of two products, which suggest that lead chromate may be used as a pigment in water-based leather finishing products. The concentration of lead chromate in the mixture could reach 33% (ICAP Leather, 2005; ICAP Leather, 2005b). We have not been able to confirm with the supplier whether what is described as lead chromate is indeed the substance under the correct CAS number or perhaps C.I. Pigment Yellow 34. Notably, the Unione Nazionale Industria Conciaria of Italy initially showed an interest in this study; however, no input was eventually made.

The Slovenian authorities have suggested that lead chromate may be present in wood impregnation products (described as "*industrial bark-liquors*"). The relatively modest consumption of lead chromate in such products between 2002 and 2009 is presented in the following table. We assume that lead chromate is used as a pigment, although we do not have specific information in this regard.

Table 4.3: Consumption of Lead Chromate Wood Impregnation Mixtures in Slovenia 2002-2009

Year	Lead chromate consumed (t)
2002	0.036
2003	0.027
2004	0.031
2005	0.019
2006	0.012
2007	0.008
2008	0.006
2009	0.002

Source: Chemicals Office of the Republic of Slovenia (2010)

4.4.2 Locations and Quantities Used

We do not have sufficient information on these aspects. The leather finishing products that have been identified are apparently manufactured in Italy but are marketed in Poland.

4.4.3 Structure of Supply Chain

Information is not available.

4.4.4 Future Trends

Information is not available.

4.5 Use as Reference Material in Art Conservation

4.5.1 Description of Use

Lead chromate (as the mineral crocoite) may be sold to conservation agencies as a reference material. The material is imported by at least one company in small quantities, at the kilogram level. Synthetic lead chromate may also be used as a reference material, as confirmed by a paint manufacturer (company **LEAD 6**). Additional detail is provided in the Confidential Annex 2.

4.5.2 Locations and Quantities Used

The reference material may be used in the conservation of historic objects of art, i.e. by museums, conservation agencies, research facilities of universities, schools for conservation, etc. The individual quantities sold could be very small (a few grams per year).

4.5.3 Structure of Supply Chain

Company **LEAD 6** has indicated that crocoite as a reference material may be supplied to ca. 200 customers across the EU.

4.5.4 Future Trends

No specific information is available, although it is understood that there must be a reasonable demand for these products from the art conservation community.

4.6 Use in Applications for which Current Use is not Conclusively Confirmed

4.6.1 Manufacture of Pigments

Description of Use

Literature: the Annex XV report for the substance refers to INRS (2005) where the use of the substance in the manufacture of pigments and dyes is mentioned. No further information from literature has been retrieved.

Consultation: testimonies collected from consultees in the course of this study largely suggest that the substance is not used in the manufacture of pigments in the EU. Eurocolor, the European trade association of pigment manufacturers which incorporates the European Manufacturers of Lead Chromate and Lead Molybdate Pigments (EMCL) has noted that EMLC members do not market lead chromate under EC Number 231-846-0, CAS Number 7758-97-6 (Eurocolour, 2010).

In addition, consultation with company **LEAD 1**, a leading manufacturer of pigments suggests that the chemical lead chromate under CAS Number 7758-97-6, is not sold anywhere in the world as a colour pigment and the company is not aware of any commercial use for this chemical. According to this company, the substance is not stable in the environment. As a result, it cannot be used to produce a stable consistent colour in paints, or plastics. The compound will darken and degrade in the presence of light. The company does not use lead chromate in the manufacture of pigments and is not aware of any other company using lead chromate in pigment manufacture. However, in principle, it might be possible that the substance is used in the manufacture of the C.I. Pigment Yellow 34 or C.I. Pigment Red 104[3].

Conclusion: testimonies of consultees would suggest that lead chromate may find very limited, if any at all, use in the manufacture of pigments within the EU.

Locations and Quantities Used

It is likely that the major source of lead chromate pigment is imports from non-EU countries. We currently have no information on possible production sites within the EU.

Structure of Supply Chain

No specific information is available.

Future Trends

No specific information is available.

4.6.2 Gelcoats and Adhesives

We have identified products that appear to contain lead chromate as a pigment and are used as gelcoats or adhesives. One such product is a pre-accelerated, isophthalic gelcoat that has been formulated for brush application (but spray versions are available). This is available in a wide range of colours (pigmented versions), including orange, that contains 5-15% lead chromate. It is apparently designed for use in the marine and building industries and for general moulding requirements (Scott Bader, 2007; Scott Bader, 2004).

Another related product that has been identified is a low density, gap-filling core adhesive for use in sandwich construction. It is formulated to bond properly prepared core materials such as rigid PVC foam and balsa to cured or semi-cured fibre-reinforced

[3] The Annex XV dossier for lead sulfochromate yellow indicates that C.I. Pigment Yellow 34 is formed by co-precipitation of lead chromate and lead sulphate in a reaction solution of sodium dichromate, sodium sulphate, lead salt (usually lead nitrate), aluminium sulphate and soda ash (sodium carbonate). The precipitation is washed with water to remove soluble compounds (Eurocolour, 2004). C.I Pigment Red 104 results from the co-precipitation of lead chromate with lead molybdate. It is also worth noting that company **LEAD 7**, a non-EU manufacturer of pigments, appears to stabilise lead chromate with silica and supply this to EU-based plastic masterbatch manufacturers.

polymer (FRP) skins. It is claimed to offer excellent adhesion, reduced weight and reduced print through compared to other methods of core bonding. This product is in fact consumed in Lithuania, according to the Lithuanian Environmental Protection Agency (2010).

We have contacted the manufacturer and the company has indicated that neither does it manufacture or nor does it use lead chromate in its products. The company uses other lead chromate pigments but not lead chromate under CAS No 7758-97-6. Downstream users may in the past have received Safety Data Sheets that mentioned lead chromate in error. The company is in the process of identifying any Sheets that mention lead chromate and replacing the lead chromate with the correct substance.

4.6.3 Detergents

The Annex XV dossier refers to the potential use of lead chromate in pigments and bleaches. Water UK (2001) notes that trace amounts of lead are known to be present in detergents, bleach and toiletries such as shampoo. INRS (2005) shows in its 2005 database of CMRs 1 and 2 in France that lead chromate may be used in the manufacturing of soaps, detergents and cleaning products. This may account for only 1.6% of the total volume used in France, or 0.8 tonne per year (this information was collected in 2005).

Bastarache (2002) refers to 'housewife eczema' linked to a chromate sensitivity phenomenon, which may arise where detergents and bleaches contain more than trace amounts of chromate salts. Kitchen Master (2010) also mentions the use of lead chromate in detergents and bleaches.

However, the International Association for Soaps, Detergents and Maintenance Products (2010) has surveyed its members and has concluded that the substance is not used in detergents and bleaches in the EU. The association suggests that the sources quoted in the Annex XV dossier may have wrongly reported this use, or this may be a very 'niche' use that the association and its members are not aware of, or it has been phased out in the meantime.

It should be noted that the association did not receive input from all members (this is not always possible as smaller companies are members of national associations, which themselves are members of the European association). In addition, some smaller companies are not members of a sector association, either national or European, so the European association cannot claim that its cover the entire EU detergents market – it does expect to cover around 80% though.

4.6.4 Embalming Products

There have been suggestions on literature found on the Internet (Bedino, 2005) that lead chromate may be found in spray skin restorative products which may be used by embalmers. We have contacted the European Association of Embalmers as well as an expert from the embalming chemicals industry (associated with company **LEAD 21**). We were advised that, apart from skin restoratives, a theoretical use of the substance would be

as a pigment in green cosmetic powder. However, no embalmer in the EU uses products that may contain lead chromate and there are several lead chromate-free alternatives. It is possible that the substance may have been used in the past. In any case, the use of cosmetics in the embalming industry is very small. The experts we have consulted questioned the validity of the claims made by Bedino (2005) in an EU context.

4.6.5 Tattoo Inks

There are several sources in scientific literature and on the Internet that suggest the use of lead chromate in tattoo inks, generally as a green ink component (pigment). Tanzi & Michael (2009), Wark (undated), the International Academy of Cosmetic Dermatology (undated) and Mate Országos Kémiai Biztonsági Intézet (undated) indicate that green tattoo ink has a number of potential ingredients, including lead chromate. According to Forte *et al* (2009), the ingredient used to produce the green pigments is mainly chromium oxide but lead chromate (chrome yellow) is also used. The chromium contained in this pigment was responsible for cutaneous sensitisation such as chronic dermatitis or dermatitis herpetiform or eczematous and pseudolymphomatous reactions in the green tattoo areas which have been reported in older studies dated between 1959 and 2008.

However, the view of the Tattoo Ink Manufacturers of Europe (2010) is that lead chromate is not used in tattoo and permanent make-up inks worldwide. We have not been able to identify any EU-based company that supplies tattoo inks that contain lead chromate. The leading pigment manufacturer, company **LEAD 1**, indicated that it has no knowledge of any lead chromate being used in tattoo inks, and it does not recommend the use of either C.I. Pigment Yellow 34 or C.I. Pigment Red 104 in this application.

4.6.6 Dentistry Products

In the course of this study, we identified a product used in dentistry that apparently contains lead chromate at a concentration of 5-10% (Wieland Dental + Technik, 2007). The product is used as protection for defined parts of surfaces to prevent them from being covered with metal during galvanisation processes. Communication with the company that markets this product suggests that the Safety Data Sheet of 2007 is incorrect. The substance actually used is lead chromate molybdate sulphate red (C.I. Pigment Red 104) rather than lead chromate.

4.6.7 Photosensitive Materials

Some patents may discuss the use of the substance in photosensitive materials (see Matsumura, undated). However, no hard evidence has been identified of such use being significant or indeed relevant to the EU. On the other hand, the submission of the German Federal Institute for Occupational Safety and Health (2010) refers to literature sources that suggest use of the substance reprographic agents and photography chemicals. Due to the lack of specific information, we have to assume that this application is not of relevance to the EU.

4.6.8 Other Uses

Lead chromate may be used as an oxidiser in analytical chemistry. It is also used in the chemical analysis of organic materials. Comments received on the Annex XV dossier for the substance (for instance, from the International Chemical Secretariat – ChemSec) also indicate its use as a pigment in printing fabrics, rubber and decorating porcelain. No additional information has been found on these potential uses.

4.7 Summary of Uses

Table 4.4 provides an overview of manufacture and uses of the substance as well as the NACE codes for the relevant activities.

Table 4.4: Overview of Uses of Lead Chromate in the EU				
Use	**NACE code**	**Transformation to another substance during use?**	**Stage of use**	**Presence of lead chromate in final product**
Manufacture of paints (incl. art conservation products)	C20.3.0: Manufacture of paints, varnishes and similar coatings, printing ink and mastics	No	Formulation	Varies; <0.1% - 25% Concentrates may have a concentration of up to 45%
	F43.3.4: Painting and glazing C25: Manufacture of fabricated metal products, except machinery and equipment R90.0.3: Artistic creation R91.0.2: Museums activities	No	Product use	Varies; part of the pigment will remain in the painted article
Manufacture of plastic masterbatches	C20.1.6: Manufacture of plastics in primary forms	No	Formulation	14-65%
	C22.2: Manufacture of plastics products	No	Formulation	0.5-1%
Manufacture of pyrotechnics	C20.5.1: Manufacture of explosives	No	Formulation	High in delay/ignition mixtures Low in detonators
	C25.4.0: Manufacture of weapons and ammunition	No	Product use	Very low in final article (shells)
Manufacture of leather tanning mixtures	C20.3 - Manufacture of paints, varnishes and similar coatings, printing ink and mastics	No	Formulation	20-33%
	C15.1.1: Tanning and dressing of leather; dressing and dyeing of fur	No	Product use	Unknown
Manufacture of wood impregnation mixtures	C20.3: Manufacture of paints, varnishes and similar coatings, printing ink and mastics	No (?)	Formulation	Unknown
	C16.2: Manufacture of products of wood, cork, straw and plaiting materials	No	Product use	Unknown
Obsolete uses and uses irrelevant to the EU				
Manufacture of pigments	C20.1.2: Manufacture of dyes and pigments	Possible, if used to make other pigments	Formulation	Unknown
Manufacture of gelcoats and adhesives and FRP maintenance products	C20.5.2: Manufacture of glues	No	Formulation	Not applicable
	C30.1.1: Building of ships and floating structures	No	Product use	Not applicable

Table 4.4: Overview of Uses of Lead Chromate in the EU				
Use	**NACE code**	**Transformation to another substance during use?**	**Stage of use**	**Presence of lead chromate in final product**
Manufacture of detergents and bleaches	C20.4.1: Manufacture of soap and detergents, cleaning and polishing preparations	No	Formulation	Unknown
Manufacture of embalming chemicals	C20.5.9: Manufacture of other chemical products n.e.c.	No	Formulation	Not applicable
Manufacture of tattoo inks	C20.3.0: Manufacture of paints, varnishes and similar coatings, printing ink and mastics	No	Formulation	Not applicable
Manufacture of dentistry products	C20.5.9: Manufacture of other chemical products n.e.c.	No	Formulation	Not applicable
Manufacture of photosensitive materials	C26.7.0: Manufacture of optical instruments and photographic equipment	No	Formulation	Unknown

4.8 Quantification of Releases from Uses of Lead Chromate

4.8.1 Releases of Lead Chromate to the Environment

Releases from Manufacture of Paints

Very limited information has become available. Data provided by company **LEAD 10** has not been included in this report after it was confirmed that the pigments used are lead substances other than lead chromate with CAS No 7758-97-6.

Another company (company **LEAD 6**) manufacturing small quantities of art conservation paints indicated no releases to air water or soil and only a very small loss (0.1% of the amount used in the manufacture of the paints) to waste.

Releases from the Use of Paints

Information on use of lead chromate paints in military and civilian applications is presented in the Confidential Annex 2. This suggests that small releases to air and waste are possible; no releases to soil or water appear to occur.

Releases from Handling of Crocoite

Some limited information on losses of lead chromate during the handling of crocoite in the manufacture of pigments and paints for art conservation is provided in the Confidential Annex 2. This only suggests a loss of 1.25-2.5% of the amount of crocoite used in the form of waste.

Releases from Use in Pyrotechnics

Company **LEAD 11,** which uses lead chromate in delay and ignition compositions has indicated that there is a small percentage of losses of the substance to air as well as in the form of waste. Additional detail is provided in the Confidential Annex 2.

Company **LEAD 19,** which also uses lead chromate in the manufacture of pyrotechnic mixtures for ignition and delay compositions estimates that there are no releases to any compartment during the use of the substance. The entire amount of lead chromate is used in the manufacturing process and in case any waste arises, this is destroyed by combustion which generally releases lead and chrome oxide. Afterwards, the solid combustion products are treated as special waste.

Releases from Detonation of Explosives

Company **LEAD 19** that manufactures ammunition that contains lead chromate pyrotechnic mixtures has suggested that the use (firing) of the ammunition may result in releases of the substance to the air and potentially to the soil, although quantification is not possible.

Other expert opinion that has been collected in the course of this study notes that lead chromate is used (in the pyrotechnic industry and in delay compositions in electric detonators for blasting) in only small quantities. In this case, it should completely react when the detonation takes place. The products released are lead (II) oxide and chromium (III) oxide (German Federal Institute for Materials Research and Testing, 2010).

Releases from Educational Uses

The Scottish Schools Equipment Research Centre[4] (2010) has advised us that lead chromate is neither purchased nor sold by educational establishments but it is adventitiously made as a by-product in some of the identification tests for lead ions. In this test, a pupil would add a few drops of 5% potassium chromate solution to a similar volume of 3% lead nitrate solution. The total amount produced per school might have added up to 3 g per school. In the distant past, each of the pupils would have washed the tiny amount of the yellow precipitate produced down the sink, but today this combined amount will be collected together for collection and disposal by a licensed waste disposal contractor.

4.8.2 Releases of and Exposure to Lead Chromate in the Working Environment

Releases and Exposure from Use in Paint Manufacture

Information on workers' exposure provided by company **LEAD 10** has been removed from the Final version of this report as being irrelevant to the substance in question. No other estimate is available.

Releases and Exposure from Paint Application

Information from consultation is considered to be commercially sensitive and is presented in the Confidential Annex 2. However, we provide below our own estimates on the basis of existing knowledge of painting applications.

This is considered to be a relatively large-scale paint job with limited possibilities for risk reduction measures, e.g. on ships, is assumed. Exposures in e.g. vehicle repair shops are much lower due to much lower amounts and much better control in the form of spray booths. Exposures in e.g. automobile industry can be much lower still due to use of automated spray robots.

Inhalation exposure was estimated using the Advanced REACH Tool (ART).The 75th percentile of the exposure distribution with the interquartile confidence range is calculated as follows:

[4] The Centre is a body funded by education authorities to provide practical advice on science and technology to schools.

- 75th percentile = 7 mg/m³; and
- interquartile range = 3.3 mg/m³ to 15 mg/m³.

Proper respiratory protection can reduce the exposure level by a factor of 10 or 20 to an estimated reasonable worst-case level of 0.75 mg/m^3.

Dermal exposure has been estimated with ECETOC TRA v2. The resulting estimates are:

- dermal exposure without LEV: 5,000 µg/cm^2 on 1,500 cm^2 à 7,500 mg paint = 3,000 mg lead chromate; and
- assuming 90% reduction by protective gloves leads to 300 mg.

Other application processes (e.g. industrial spraying on small scale, rolling and brushing, dipping) will lead to lower exposure levels, both by inhalation and dermal.

Releases and Exposure from Use in Pyrotechnics Manufacture

Information from two companies (**LEAD 11** and **LEAD 19**) is presented in the Confidential Annex 2. This information suggests that, for pyrotechnic use, worker exposure to lead chromate is very low, if any.

Releases and Exposure from Use in the Manufacture of Other Lead Chromate Pigments

Error! Reference source not found. present calculations relating to the potential (but yet unconfirmed) use of lead chromate in the manufacture of other lead chromate pigments (C.I. Pigment Yellow 34 and/or C.I. Pigment Red 104).

Inhalation exposure was estimated using the Advanced REACH Tool (ART). The 75th percentile of the exposure distribution with the interquartile confidence range is calculated as follows:

- for **dumping**:
  - 75th percentile = 0.26 mg/m³;
  - interquartile range = 0.14 mg/m³ to 0.49 mg/m³; and
  - reasonable worst case estimate of inhalation exposure by ART is 0.49 mg/m^3 (490 µg/m^3);

- for **vacuum transfer**:
  - 75th percentile = 0.0077 mg/m³;
  - interquartile range = 0.0041 mg/m³ to 0.015 mg/m³; and
  - reasonable worst-case estimate of inhalation exposure by ART is 0.015 mg/m^3 (15 µg/m^3).

Dermal exposure has been estimated with ECETOC TRA v2 as follows:

- for **dumping**:
  - dermal exposure with LEV: 10 µg/cm^2 on 960 cm^2 à 9.6 mg lead chromate;
  - dermal exposure without LEV: 1000 µg/cm^2 on 960 cm^2 à 960 mg lead chromate;
  - assuming 90% reduction by protective gloves leads to 0.96 mg (with LEV) and 96 mg (without LEV);

- for **vacuum transfer**:
  - dermal exposure with LEV: 100 µg/cm^2 on 480 cm^2 à 48 mg lead chromate;
  - dermal exposure without LEV: 1000 µg/cm^2 on 480 cm^2 à 480 mg lead chromate; and
  - assuming 90% reduction by protective gloves leads to 4.8 mg (with LEV) and 48 mg (without LEV).

4.8.3 Consumer Exposure to Lead Chromate

NICNAS (2007) notes that because lead chromates are used as pigments in vehicle refinishing paints, DIY car restoration and body work may expose the public to compounds which are possible carcinogens. However, the classification of lead chromate should prevent it being used in products placed on the market for DIY use.

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ANNEX 1. EXPOSURE MODEL CALCULATION ASSUMPTIONS

A1.1 Releases and Exposure from the Use of Lead Chromate-based Paint

Table A1.1 summarises the parameters used in the Advanced REACH Tool (ART) model for estimating inhalation exposure from the application of paints that contain lead chromate.

Table A1.1: Assumptions made for Estimating Occupational Inhalation Exposure to Lead Chromate during Application of Paints

Input parameter	Value	Remark
Substance/product type	Powders dissolved in liquid or incorporated in a liquid matrix	
Liquid matrix fraction	0.4	40% as a reasonable worst case taken from the report
Situation	Moderate application rate (0.3 - 3 l/minute)	Value indicated for spraying in ship painting in ART
Spray direction	In any direction (including upwards)	Worst case option
Spray technique	Spraying with no or low compressed air use	e.g. airless spraying, one of the least worst case options
Process fully enclosed?	No	
Effective housekeeping practices in place?	Yes	General assumption
Work area	Indoors	
Room size	Large workrooms only	Given the large areas involved
Primary localised control	Other LEV	E.g. spray wall; least effective type of LEV in ART
Ventilation rate	Mechanical ventilation giving at least 3 ACH	
Duration activity	360 min	Relatively large scale spraying is possible
No exposure period	120 min	
Source: TNO calculations		

Table A1.2 summarises the parameters used in the ECETOC TRA v2 model for estimating dermal exposure from the application of paints that contain lead chromate.

Table A1.2: Assumptions made for Estimating Occupational Dermal Exposure to Lead Chromate during Application of Paints

Input parameter	Value	Remark
Substance/product type	Solid	
Activity (PROC)	PROC 11: Non-industrial spraying	Most relevant option for e.g. ship spraying
Local Exhaust Ventilation (LEV)	No	Effect of LEV in this type of spraying on dermal exposure is considered to be very low
Weight fraction	0.4	40% in paint as reasonable worst case value
Source: TNO calculations		

A1.2 Releases and Exposure from Use in the Manufacture of Lead Chromate Pigments

Table A1.3 summarises the parameters used in the Advanced REACH Tool (ART) model for estimating inhalation exposure from the use of lead chromate in the manufacture of other lead chromate pigments.

Table A1.3: Assumptions made for Estimating Occupational Inhalation Exposure to Lead Chromate during Manufacture of Other Lead Chromate Pigments

Input parameter	Value	Remark
Substance/product type	Powders, granules or pelletised material	
Dustiness	Coarse dust	Medium level dustiness in ART
Moisture content	Dry product (<5% moisture content)	
Powder weight fraction	1	Pure lead chromate
Activity class (1)	Falling powders	
Activity class (2, alternative)	Vacuum transfer	More careful handling
Situation	Transferring 10-100 kg/minute	Value indicated for dumping of powders in ART
Handling type	Routine transfer	Since the substance is not explosive, routine transfer is assumed
Drop height	< 0.5 m	Only for falling powders
Containment level (1)	Open process	Manual scooping
Containment level (2, alternative)	Handling that reduces contact between product and adjacent air	Vacuum transfer
Process fully enclosed?	No	
Effective housekeeping practices in place?	Yes	Expected due to the type of substances handled
Work area	Indoors	
Room size	Any size workroom	
Primary localised control	LEV: fixed capturing hoot	
Ventilation rate	Mechanical ventilation giving at least 3 ACH	
Duration activity	120 min	
No exposure period	360 min	

Source: TNO calculations

Table A1.4 summarises the parameters used in the ECETOC TRA v2 model for estimating dermal exposure from the use of lead chromate in the manufacture of other lead chromate pigments.

Table A1.4: Estimated Occupational Dermal Exposure to Lead Chromate during Application of Paints		
Input parameter	**Value**	**Remark**
Substance/product type	Solid	
Activity (PROC) (1)	PROC 8a: Transfer of chemicals from/to vessels/large containers at non-dedicated facilities	Most relevant option for open dumping
Activity (PROC) (2, alternative)	PROC 8b: Transfer of chemicals from/to vessels/large containers at dedicated facilities	Most relevant option for vacuum transfer
Local Exhaust Ventilation (LEV)	Yes	
Weight fraction	1.0	Pure lead chromate
Source: TNO calculations		