

**Substance Name: Chrysene**

**EC Number: 205-923-4**

**CAS Number: 218-01-9**

**MEMBER STATE COMMITTEE**

**SUPPORT DOCUMENT**

**FOR IDENTIFICATION OF**

**CHRYSENE**

**AS A SUBSTANCE OF VERY HIGH CONCERN BECAUSE  
OF ITS CARCINOGENIC (ARTICLE 57A), PBT<sup>1</sup>  
(ARTICLE 57D) AND vPvB<sup>2</sup> (ARTICLE 57E)  
PROPERTIES**

**Adopted on 30 November 2017**

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<sup>1</sup> PBT means persistent, bioaccumulative and toxic

<sup>2</sup> vPvB means very persistent and very bioaccumulative

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## FOREWORD

Chrysene (CHR) belongs to the eight Polycyclic Aromatic Hydrocarbons (PAHs) that have a harmonised classification, according to the CLP Regulation (EC 1272/2008) as a Class 1B carcinogen and a Class 2 mutagen.

Seven further PAHs have a harmonised classification as carcinogenic and/or mutagenic and/or reprotoxic in the categories 1A, 1B, or 2 according to the CLP Regulation (EC 1272/2008).

Until now, several Annex XV dossiers for the identification of substances of very high concern (SVHC) were explicitly based on the properties of PAHs as constituents of concern in the identified substances, such as Anthracene, Anthracene Oils, Coal Tar Pitch High Temperature (CTPHT).

CHR is constituent, inter alia, in CTPHT. In the Support Document of Pitch, coal tar, high temp. (CTPHT) it has been concluded by the Member State Committee (MSC) that chrysene fulfils the PBT and vPvB criteria of Annex XIII to the REACH Regulation (ECHA, 2009). However, CHR and further PAHs whose properties have already been agreed on by the MSC in the CTPHT SVHC identification process have not yet been proposed for formal SVHC identification and inclusion in the Candidate List.

The information which was available and led to the conclusion that CHR is a SVHC is summarised in the support document for CTPHT (ECHA, 2009). This information is still valid and allows compact review of the substance properties with a focus on PBT/vPvB. Therefore, the SVHC identification of CHR in this current dossier is mainly based on the information provided in that support document.

In the following, the abbreviation CHR is used for the substance chrysene.

## **IDENTIFICATION OF A SUBSTANCE OF VERY HIGH CONCERN ON THE BASIS OF THE CRITERIA SET OUT IN REACH ARTICLE 57**

**Substance Name:** Chrysene (CHR)

**EC Number:** 205-923-4

**CAS number:** 218-01-9

- The substance is identified as a substance meeting the criteria of Article 57 (a) of Regulation (EC) No 1907/2006 (REACH) owing to its classification in the hazard class carcinogenicity category 1B<sup>3</sup>.
- The substance is identified as persistent, bioaccumulative and toxic (PBT) according to Article 57 (d) of Regulation (EC) No 1907/2006 (REACH).
- The substance is identified as very persistent and very bioaccumulative (vPvB) according to Article 57 (e) of Regulation (EC) No 1907/2006 (REACH).

### **Summary of how the substance meets the criteria set out in Article 57 of the REACH Regulation**

#### Carcinogenic - Article 57 (a):

Chrysene is listed by index number 601-048-00-0 of Regulation (EC) No 1272/2008 in Annex VI, part 3, Table 3.1 (the list of harmonised classification and labelling of hazardous substances) and it is classified in the hazard class carcinogenicity category 1B (hazard statement H350: "May cause cancer").

Therefore, this classification of the substance in Regulation (EC) No 1272/2008 shows that it meets the criteria for classification in the hazard class:

- Carcinogenicity category 1B in accordance with Article 57 (a) of REACH.

#### PBT/vPvB - Articles 57 (d) and (e):

An assessment of the PBT/vPvB properties of CHR has already been carried out by the MSC in the context of the identification of CTPHT as SVHC, as documented in the MSC Support Document for identification of CTPHT as SVHC (ECHA, 2009), supplemented with information becoming available since that date. Additional information was assessed earlier in the EU Risk Assessment Report on CTPHT (European Commission, 2008) and the Annex XV Transitional Dossier on CTPHT (NL, 2008). Both reports support the conclusions on the PBT and vPvB properties of CHR already drawn in the MSC Support Document on CTPHT. The information leading to the identification of CTPHT as SVHC is still valid and allow compact assessment of the substance properties with a focus on PBT/vPvB.

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<sup>3</sup> Classification in accordance with section 3 of Annex I to Regulation (EC) No 1272/2008.

Persistence

Based on the available information from experimental and estimated data, CHR degrades very slowly in soil with half-lives of > 180 d. Thus, the P and the vP criteria of REACH Annex XIII are fulfilled.

Bioaccumulation

The bioaccumulation of CHR in Crustacea were measured and BCFs > 5000 obtained. Thus, the B and the vB criteria of REACH Annex XIII are fulfilled.

Toxicity (only relevant for PBT substances)

CHR is classified in the hazard class carcinogenicity category 1B according to EU Regulation 1272/2008. Thus, the T criterion of REACH Annex XIII 1.1.3 b) is fulfilled.

Overall conclusion

In conclusion, chrysene meets the criteria for a PBT and vPvB substance according to Article 57 (d) and (e) of REACH, based on weight-of-evidence determination and the criteria for carcinogenicity to Article 57 (a) of the REACH Regulation.

**Registration dossiers submitted for the substance: No**

## Justification

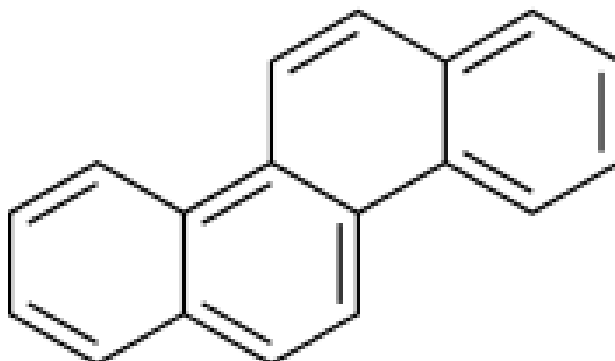
### 1. Identity of the substance and physical and chemical properties

#### 1.1 Name and other identifiers of the substance

Table 1: Substance identity

<b>EC number:</b>	205-923-4
<b>EC name:</b>	Chrysene
<b>CAS number (in the EC inventory):</b>	218-01-9
<b>CAS number: Deleted CAS numbers:</b>	
<b>CAS name:</b>	chrysene
<b>IUPAC name:</b>	chrysene
<b>Index number in Annex VI of the CLP Regulation</b>	601-048-00-0
<b>Molecular formula:</b>	C <sub>18</sub> H <sub>12</sub>
<b>Molecular weight range:</b>	228.29
<b>Synonyms:</b>	Benzo[a]phenanthrene 1,2-Benzphenanthrene 1,2-Benzophenanthrene Chrysen (CHR) Chrysene

#### Structural formula:



#### 1.2 Composition of the substance

**Name:** chrysene

**Description:** Chrysene (CHR) belongs to the group of Polycyclic Aromatic Hydrocarbons (PAHs). CHR is not produced, as such. However, it may occur as a constituent - often together with other PAHs - in UVCB<sup>4</sup> that are derived from coal or in several petroleum streams. The dossier addresses the substance CHR as a substance itself and not in the context of its original occurrence in UVCB.

**Substance type:** mono-constituent

### 1.3 Physicochemical properties

**Table 2: Overview of physicochemical properties**

Property	Description of key information	Value [Unit]	Reference/source of information
<b>Physical state at 20°C and 101.3 kPa</b>		<i>solid</i>	<i>GSBL database, accessed at Mar-23-2017</i>
<b>Melting/freezing point</b>		255.5°C	Mackay, 2006
<b>Boiling point</b>		448 °C	Mackay, 2006
<b>Vapour pressure</b>	reported vapour pressure values are within the range between of the two indicated values (3 <sup>rd</sup> column)	8.4 x 10 <sup>-7</sup> Pa at 25°C (effusion method)  1.7 x10 <sup>-4</sup> Pa at 20°C (supercooled liquid PL)	Mackay, 2006
<b>Density</b>		e.g. 1.274 g/m <sup>3</sup> at 20°C	Mackay, 2006
<b>Water solubility</b>	reported water solubility values are within the range of the two indicated values (3 <sup>rd</sup> column)	1.0 µg L <sup>-1</sup> - 3.3 µg L <sup>-1</sup>	Mackay, 2006
<b>Partition coefficient n-octanol/water (log value)</b>		log Kow 5.73 at 25°C	Mackay, 2006

<sup>4</sup> Substances of Unknown or Variable composition, Complex reaction products or Biological materials

## 2. Harmonised classification and labelling

Chrysene is listed by Index number 601-048-00-0 in part 3 of Annex VI to the CLP Regulation as follows:

**Table 3: Classification according to Annex VI, Table 3.1 (list of harmonised classification and labelling of hazardous substances) of Regulation (EC) No 1272/2008**

Index No	International Chemical Identification	EC No	CAS No	Classification		Labelling			Spec. Conc. Limits, M-factors	Notes
				Hazard Class and Category Code(s)	Hazard statement code(s)	Pictogram, Signal Word Code(s)	Hazard statement code(s)	Suppl. Hazard statement code(s)		
601-048-00-0	Chrysene	205-923-4	218-01-9	Carc. 1B	H350	GHS08	H350			
				Muta. 2						
				Aquatic Acute 1	H341	GHS09	H341			
				Aquatic Chronic 1	H400		Dgr			H410
	H410									

## 3. Environmental fate properties

### 3.1 Degradation

The data provided on degradation of CHR in the Support Document for identification of CTPHT as SVHC (ECHA, 2009) are not assessed or discussed again in this dossier but included for convenience (flagged by *italic print*). Additional information available in the EU risk assessment report on CTPHT (EC, 2008) and the Annex XV Transitional Dossier for CTPHT (The Netherlands, 2008) but not discussed in the support document was included.

#### 3.1.1 Abiotic degradation

##### 3.1.1.2 Hydrolysis

As assessed before in the Support Document for identification of CTPHT as SVHC (ECHA, 2009), *PAHs are hydrolytically stable in aqueous systems*. The Support Document furthermore states as a result that *hydrolysis does not contribute to the degradation of PAHs under environmental conditions*.

##### 3.1.1.3 Oxidation

The oxidation of PAHs was summarised and discussed in the Support Document for identification of CTPHT as SVHC (ECHA, 2009) as follows:

*In the atmosphere, the PAHs are either gas phase or particle-associated. It has been shown that the 2-4 ring PAHs with vapour pressure higher than or equal to  $10^{-4}$  Pa are mostly gas phase-related and PAHs of 4 rings or more with vapour pressure below  $10^{-4}$  Pa are particle-associated. In the gas phase PAHs are oxidised by atmospheric hydroxyl (OH) and nitrate radicals and ozone, whereas the particle-associated PAHs are expected to be degraded by direct photolysis and by reaction with ozone (The Netherlands, 2008).*

CHR has 4 aromatic rings and a reported vapour pressure are at  $1.7 \times 10^{-4}$  Pa or lower. Therefore it is assumed that CHR is mainly particle associated and is degraded by



photolysis instead of oxidization.

### 3.1.1.3 Photo-transformation/photolysis

#### **3.1.1.3.1 Photo-transformation in air**

Photolysis of PAHs in the atmosphere was assessed in the EU risk assessment report (2008) as following:

*Photolysis in the troposphere results in the formation of reactive hydroxyl and nitrate (NO<sub>3</sub>) radicals and ozone (O<sub>3</sub>), which reacts as oxidizing agent with organic compounds, like PAHs. These radical and ozone reactions comprise mainly degradation of gas-phase PAHs (Calvert et al., 2002). Particle-associated PAHs are expected to degrade in air predominantly via direct photolysis by light with a wavelength < 290 nm (Kamens et al., 1988), although reaction with ozone will also occur (Peters and Seifert, 1980; Grosjean et al., 1983; Pitts et al., 1986; Coutant et al., 1988).*

As stated earlier, CHR is mainly particle associated. The degradation rate of PAHs, and therefore of CHR, depends on the type of particle to which they are bound (Behymer & Hites, 1988, cited in The Netherlands, 2008). While half-lives for direct photolysis of PAH are in the range of hours (Vu Duc & Huynh, 1991, cited in The Netherlands, 2008), it was demonstrated by European Commission (2001) (cited in The Netherlands (2008)), that particle surface-adsorbed CHR does have representative lifetimes between 10 hr and 7.8 days under natural conditions. According to the Annex XV Transitional Dossier for CTPHT (The Netherlands, 2008), the photolysis of PAHs is as follows:

*A two layer model has been proposed for the behaviour of naturally occurring PAH on airborne particulate matter, in which photo oxidation takes place in the outer layer, and much slower, 'dark' oxidation takes place in the inner layer (Valerio et al., 1987). This model is in line with the results of Kamens et al. (1991), who reported that PAH on highly loaded particles degrade more slowly than those on particles with low loads. As PAH occur mainly on particulate matter with a high carbon content, their degradation in the atmosphere is slower than that of PAH in the vapour phase under laboratory conditions or adsorbed on synthetic material.*

#### **3.1.1.3.2 Photo-transformation in water**

As assessed before in the Support Document for identification of CTPHT as SVHC (ECHA, 2009), *Photo-degradation in natural waters takes normally place only in the upper few centimetres of the water-column and is therefore not considered to have significant impact on the overall persistency of PAHs in the aquatic environment.*

#### **3.1.1.3.3 Photo-transformation in soil**

As assessed before in the Support Document for identification of CTPHT as SVHC (ECHA, 2009), *exposure to light is even more limited in soils, photo-degradation is as well not considered a relevant degradation process in terrestrial environments.*

### 3.1.1.4 Summary on abiotic degradation

It is concluded that in the atmosphere, free PAHs degrade within minutes to hours by direct photolysis. The substance is however mostly particle-associated. Depending on the type of associated particle the lifetime of CHR can increase up to 7.8 day. In water, CHR is not hydrolysed but can be photo-degraded. However, this only appears at the upper few centimetres of a water-column and is therefore not considered having a significant impact on the overall persistence of CHR in the aquatic environment. In soil, exposure to light is even more limited. Thus, photo-degradation is not considered as relevant degradation

process in water and terrestrial environments. CHR is hydrolytically stable under environmental conditions.

This conclusion was already drawn in the Support Document for identification of CTPHT as SVHC (ECHA, 2009).

### **3.1.2 Biodegradation**

#### **3.1.2.1 Biodegradation in water and sediments**

The biodegradation in water was already assessed in the Support Document for identification of CTPHT as SVHC (ECHA, 2009) and will not be assessed again within this dossier.

Tests for biodegradation in water have demonstrated that PAHs with up to four aromatic rings are biodegradable under aerobic conditions, but that biodegradation rates of PAHs with more aromatic rings are very low (The Netherlands, 2008).

As assessed in the Support Document for identification of CTPHT as SVHC (ECHA, 2009):

*In general, the biodegradation rates decrease with increasing number of aromatic rings. This correlation has been attributed to factors like the bacterial uptake rate and the bioavailability. The bacterial uptake rate has been shown to be lower for the higher molecular weight PAHs as compared to the PAHs of lower molecular weight. This may be due to the size of high molecular weight members, which limits their ability to cross cellular membranes. In addition, bioavailability is lower for higher molecular PAHs due to adsorption to organic matter in water and sediment. It has further been shown that half-lives of PAHs in estuarine sediment are proportionally related to the octanol-water partition coefficient (Kow) (Durant et al, (1995) cited in The Netherlands, 2008).*

[...]

*In general, PAHs are considered to be persistent under anaerobic conditions (Neff (1979); Volkering and Breure (2003) cited in The Netherlands, 2008). Aquatic sediments are often anaerobic with the exception of a few millimetre thick surface layer at the sediment-water interface, which may be dominated by aerobic conditions. The degradation of PAHs in aquatic sediments is therefore expected to be very slow.*

#### **3.1.2.1.1 Estimated data**

As assessed in the Support Document for identification of CTPHT as SVHC (ECHA, 2009) Mackay et al. (1992) estimated half-lives in the different environmental compartments based on model calculations and literature research. The calculated half-lives of CHR in water are in the range of 42 to 125 days and for sediment longer than 1250 days (The Netherlands, 2008).

#### **3.1.2.2 Biodegradation in soil**

Biodegradation in soil was assessed in the Support Document for identification of CTPHT as SVHC (ECHA, 2009) as follows:

*Biodegradation rates of PAHs in soil depend on several factors related to the soil type, including pH, moisture content, nutrients, oxygen, and the diversity of the soil microbial population. Various species (bacteria, fungi, yeasts and algae) are known to degrade PAHs in soil (The Netherlands, 2008). It has been shown that the number of PAH-degrading microorganisms and the degradation capacity is higher in PAH-contaminated soils than in pristine soils, something explained by the development of an adapted soil microbial*

community. Several studies have also been demonstrated enhanced PAH-degradation rates when the soil had been enriched with isolated PAH-degrading microorganisms ([...] The Netherlands, 2008). On the basis of a comparison between two studies (Wild et al. 1991 and Wild and Jones, 1993) it was illustrated that the half-lives observed under laboratory conditions can be much shorter than those obtained from long-term field studies. This was attributed by the authors to the more optimal conditions (temperature, moisture content, nutrient and oxygen supply) applied in the laboratory tests.

Wild and Jones (1993) and Wild et al. (1991) studied the biodegradation of PAHs in soil amended with sewage sludge under laboratory and field conditions, respectively.

They determined a dissipation half-life for CHR in the range of 106 to 313 days in laboratory soil microcosms and under field condition a half-life of 8.1 years. Wild et al. (1991) summarized, *that biodegradation is the key process in PAH losses from these soils.*

The laboratory study done by Wild and Jones (1993) was conducted at a temperature range between 20 and 30°C. The field study Jones et al. (1991) was conducted at Luddington and Lee Valley, in the UK.

In addition Mackay et al. (1992) as summarised by The Netherlands (2008) suggested a half-life for CHR in the range of 420 to 1250 days in soil. These predictions are in line with half-lives observed under laboratory conditions or under environmental conditions (field data).

Further the Support Document for identification of CTPHT as SVHC (ECHA, 2009) discusses "aging" for PAHs as following:

*"Aging' is a phenomenon associated with increased residence time of PAHs in soil, which can further decrease the bioavailability of PAHs in the terrestrial environment. Freshly spiked PAHs are more readily desorbed and thus more bioavailable than PAHs that have been in soil or sediment for a longer period of time (The Netherlands, 2008). This means that studies involving artificially added PAHs (e.g. 14C-labelled) often result in biodegradation rates much higher than rates observed for the same substances present in soil as part of a contamination by coal tar."*

### 3.1.2.3 Summary and discussion on biodegradation

The half-life predicted by Mackay et al. (1992) indicates that CHR persists in sediment with half-lives higher than 1250 days. For water degradation, Mackay et al. (1992) predicted long elimination half-lives between 42 and 125 days. However, considering the chemical structure of CHR that consists of four aromatic rings, standard tests for biodegradation in water may reveal that CHR is biodegradable under aerobic conditions (EC, 2008). Biodegradation studies in laboratory soil microcosms show dissipation half-lives up to 313 days (Wild and Jones, 1993). Biodegradation studies on soil done by Wild et al. (1991) revealed a half-life of CHR of more than 8.1 years under field conditions.

Hence, CHR biodegrades very slowly in sediments and soil.

This conclusion was already drawn in the Support Document for identification of CTPHT as SVHC (ECHA, 2009).

### 3.1.3 Summary and discussion of degradation

CHR has a low water solubility and shows a high tendency to adsorb to particles and organic matter in the environment. The resulting low bioavailability is one of the limiting factors of its biodegradation.

The predicted half-lives range between 42 and 125 days for water degradation and half-lives higher than 1250 days for sediment. Wild and Jones (1993) reported a dissipation half-life for CHR of 106 to 313 days in a laboratory soil microcosm study. For assessing the persistence of CHR, half-lives obtained under realistic conditions, such as field conditions, are given higher weight. Under field conditions Wild et al. (1991) demonstrated a half-life of more than 8.1 years in soil for CHR.

It is conclusive that CHR degrades very slowly in sediment and soil.

## 3.2 Environmental distribution

### 3.2.1 Adsorption/desorption

In the Support Document for identification of CTPHT as SVHC (ECHA, 2009) the adsorption properties of PAHs are described as follows:

*“A linear relationship between  $K_{ow}$  and the organic carbon-water partitioning coefficient  $K_{oc}$  has been demonstrated for PAHs in sediments and soil. The Log  $K_{ow}$  values from 4.6 to 6.6 can be translated as a high potential for partitioning to soils and sediments. Partitioning processes like adsorption to airborne particulate matter, as well as accumulation in sludge during wastewater treatment, have been demonstrated especially for high molecular weight PAHs (The Netherlands, 2008).”*

CHR has a Log  $K_{ow}$  value of 5.73. It is therefore concluded that CHR has a high potential to adsorb to particles in the environment.

### 3.2.2 Volatilisation

CHR has reported vapour pressure values between  $8.4 \times 10^{-7}$  Pa at 25°C and  $1.7 \times 10^{-4}$  Pa at 20°C (Mackay et al., 2006). It is therefore concluded that CHR is expected to volatilise very slowly. Further The Netherlands (2008) concluded, that *“volatilisation of PAHs is insignificant”*.

### 3.2.3 Distribution modelling

Mackay Level III fugacity modelling was done using EPI Suite (version 4.11) with default values of environmental emission rates (it is assumed that CHR is released at equal rates to air, water and soil) and default values of physico-chemical properties (done in April 2017). Calculation revealed a distribution of CHR to soil and sediment phase (table 4).

Table 4: Fugacity Model calculation (EPI Suite, version 4.11) of CHR

Distribution to:	Mass amount (percent)
Air	0.058
Water	4.33
Soil	47.6
Sediment	48

### 3.2.4 Summary and discussion of environmental distribution

CHR has a high potential to adsorb to particles and volatilisation of CHR is insignificant.

Further modelling the fugacity reveals that CHR is mainly distributed in soil and sediment.

### 3.3 Data indicating potential for long-range transport

No data indicating potential for long-range transport are reviewed in the scope of this dossier.

### 3.4 Bioaccumulation

#### 3.4.1 Bioaccumulation in aquatic organisms (pelagic & sediment organisms)

For CHR only one experimental BCF study was considered in the Support Document for the Identification of CTPHT as SVHC (ECHA, 2009).

Newstedt and Giesy (1987) studied an experimental BCF value at steady state in a static-renewal system and reported a BCF = 6088 for CHR in *D. magna*. In this study the bioconcentration factor was determined for a range of PAHs. The study was evaluated in the Support Document for the Identification of CTPHT as SVHC (ECHA, 2009).

More experimental BCF studies have been assessed by Verbruggen and van Herwijnen (2011a). One reliable (reliability 2) low BCF value of 13 was reported for fish (*D. rerio*, Hooftman and Evers-de Ruiter, 1992, cited in Verbruggen and van Herwijnen, 2011a).

Further two studies are available that provide BCF data for rainbow trout: 450 (Gobas & Lo 2016) and 153 (EMBSI, 2009). In EMBSI (2009), the method used is based on the OECD TG 305, with improvements in maintaining dissolved test exposure based on passive dosing. Also three laboratory fish dietary studies are available for CHR showing BMF values far below 1: BMF 0.016 (EMBSI, 2006), BMF 0.04 (EMBSI 2008) and BMF 0.004 (Lo et al, 2015). Additionally reference is made to data from a US EPA BSAF database (US Environmental Protection Agency, 2008) provides information on field-derived fish BSAF factors for 17 PAHs, CHR included. The median and 90th percentile for CHR, are less than 0.01.

Additional support for the bioaccumulating properties of CHR can be gained via comparison with a similar substance. The Octanol-water partitioning coefficient is used as indication for B or vB properties. A PAH with a logK<sub>ow</sub> in a range similar to CHR (logK<sub>ow</sub> = 5.73) is Benz[a]anthracene (BaA, EC: 200-280-6; logK<sub>ow</sub> = 5.91). Both substances also have a very similar chemical structure and the same molecular weight. BaA was used in experimental studies for BCF more extensively. An overview of BCFs determined for aquatic organisms is given in ECHA (2009) and more detailed in The Netherlands (2008). Briefly, for BaA the following considerations on bioaccumulation in aquatic organism have been taken: The bioaccumulation potential of BaA differs between the organisms due to the organisms' ability to metabolise PAHs (biotransformation). BaA can be transformed in fish using enzymes belonging to the Cytochrome P450 enzymes (Cyt P450) and other mechanisms. Low reliable experimental BCF values of 200 to 265 have been obtained for BaA in fish (De Maagd et al., 1996, 1998, rated with reliability 2 by Verbruggen and van Herwijnen, 2011b). Among crustaceans an experimental BCF value above 5000 has been reported for BaA in *Daphnia magna* as it is also the case for CHR (Newsted & Giesy, 1987). In addition high reliable experimental BCF values are available for BaA in *Pontoporeia hoyi* (63000, Landrum, 1988, rated with reliability 1 by Verbruggen and van Herwijnen, 2011b) and in *D. pulex* (10109, Southworth et al., 1978, rated with reliability 2 by Verbruggen and van Herwijnen, 2011b). Based on the bioaccumulation data for organisms of lower trophic levels it is concluded that BaA is a bioaccumulative and very bioaccumulative substance.

It might be likely, that the same mechanism leads to a bioaccumulation of CHR in organisms of lower trophic levels.

### **3.4.2 Bioaccumulation in terrestrial organisms (soil dwelling organisms, vertebrates)**

The European Union Risk Assessment Report on CTPHT (EC, 2008) reported a QSAR estimated BCF value for CHR in *Eisenia andrei* of  $BCF_{\text{earthworm}}=7800$  and this value is considered to represent a reasonable worst case. The documentation of this QSAR result does not comply with REACH Annex XI and thus its reliability is limited.

### **3.4.3 Field data**

Some BAF values obtained from field samples are available for CHR and have been assessed by Verbruggen and van Herwijnen (2011a). High lipid normalised BAF values have been obtained in a study for a crab species (30800 L/kgww for *Hemigrapsus penicillatus*) and Molluscs (103000 - 177000 L/kgww, Takeuchi *et al.*, 2009). Also for a fish species a lipid normalised BAF value of 21700 has been obtained in this study. This study has been rated with reliability 2 by Verbruggen and van Herwijnen (2011a). Comparable results have been obtained for BaA in the same study (cited in Verbruggen *et al.*, 2011b).

New trophic magnification studies are available as well. Four different studies from different global locations provide information on the TMF for PAHs – including CHR: TMF from Bohai Bay of 0.26 (Wan *et al.* 2007), TMF from the Baltic Sea of 0.66 (Nfon *et al.* 2008), TMF from Tokyo Bay of 0.65 (Takeuchi *et al.* 2009) and TMF from the Passaic River estuary of 0.17 (Khairy *et al.* 2014).

### **3.4.4 Summary and discussion of bioaccumulation**

Bioaccumulation potential of CHR likely differs between the organisms due to the organism's ability to metabolise PAHs (biotransformation). It is likely that CHR is transformed in fish using enzymes belonging to the Cytochrome P450 enzymes (Cyt P450) resulting in low BCF values. Also molluscs might have the ability to metabolise PAHs to some extent. However, BAF data give a clear concern for bioaccumulation in molluscs. Among crustaceans an experimental BCF value above 5000 (Newsted & Giesy, 1987) has been reported for *Daphnia magna* and a high BAF value has been obtained for a crab species from a field sample (Takeuchi *et al.*, 2009 cited in Verbruggen and van Herwijnen, 2011a). No evidence for transformation processes of PAHs in algae and oligochaeta exist.

Thus, CHR has a high bioaccumulation potential at lower trophic levels, which could contribute to a constant high exposure of CHR to predators for which the effects are unpredictable due to the absence of sufficient data.

The TMFs <1 observed cannot refute the evidence of high bioaccumulation potential in lower trophic levels as TMFs reflect the average magnification along the food web trophic levels. Furthermore, a high BAF value has been reported for a benthic fish species feeding largely on invertebrates, amounting to 21,700 L/kgww (Takeuchi *et al.*, 2009 cited in Verbruggen and van Herwijnen, 2011).

Thus, it is concluded that CHR is a bioaccumulative and very bioaccumulative substance.

This conclusion was already drawn in the Support Document for identification of CTPHT as SVHC (ECHA, 2009).

## 4. Human health hazard assessment

Information on hazard to human health relevant for the identification of the substance as SVHC in accordance with Article 57 points (a) to (c) of the REACH Regulation is provided in Section 2 of this report (see harmonised classification and labelling of CHR in Section 2 as Carc. 1B, H350).

### **PBT considerations regarding human health hazard assessment:**

CHR is classified in the hazard class carcinogenicity category 1B according to EU Regulation 1272/2008. Thus, the T criterion of REACH Annex XIII 1.1.3 b) is fulfilled.

## 5. Environmental hazard assessment

### 5.1 Aquatic compartment (including sediment)

The Support Document for the identification of CTPHT as SVHC summarises the following on environmental hazard assessment for the aquatic compartment.

*PAHs can be toxic via different modes of action, such as non-polar narcosis and photo-toxicity. Photo-toxicity is caused by the ability of PAHs to absorb UVA radiation, UVB radiation, and in some instances, visible light. It may occur as the result of the production of singlet oxygen, which is highly damaging to biological material, or as result of the formation of new, more toxic compounds from the photo-modification (usually oxidation) of PAHs (Lampi et al., 2006). Phototoxic effects can be observed after a short period of exposure, which explains why for PAHs like anthracene, fluoranthene and pyrene, where photo-toxicity is most evident, the acute toxicity values under simulated solar radiation may be lower than the chronic toxicity values determined under less harsh radiation.*

*The photo-toxicity of PAHs is relevant where the PAHs are exposed to light and UV radiation, and considered to be most important for upper layers of aquatic and terrestrial environments. Although UV penetration depths may vary among PAH-contaminated sites, it is not unlikely that significant portions of the aquatic community may be exposed to UV levels sufficient to induce photo-toxicity, as UV levels occurring under normal sun light conditions have been shown to elicit these effects. There is growing evidence which suggests that phototoxic PAHs may be degrading aquatic habitats, particularly those in highly contaminated areas with shallow or clear water. Photo-induced chronic effects have been reported for anthracene at UV intensities occurring at depths of 10-12 m in Lake Michigan (Holst & Giesy, 1989). Photo-toxicity of PAHs may also be initiated in aquatic organisms which have accumulated PAHs from the sediment and subsequently are exposed to sun light closer to the surface (The Netherlands, 2008). Phototoxic effects of PAHs are therefore considered relevant in this hazard, respectively T- assessment.*

#### 5.1.1 Fish

##### 5.1.1.1 Short-term toxicity to fish

No standard test data on short-term toxicity to fish are available (search done April 2017).

##### 5.1.1.2 Long-term toxicity to fish

No data on long-term toxicity to fish are available (search done April 2017).

There are only very few data available on CHR. Evaluation on long-term toxicity of CHR to

fish was reported as following in the Support Document for identification of CTPHT as SVHC (ECHA, 2009):

*The water solubility of chrysene is about 1.6 µg/l, with a range between 1.0 and 3.3 µg/l (Mackay et al., 2006). Around or below this value, no significant effects were observed for any species in a regular toxicity experiment, although chronic toxicity studies were performed with algae, crustaceans (including Daphnia) and fish.*

### **5.1.2 Aquatic invertebrates**

#### **5.1.2.1 Short-term toxicity to aquatic invertebrates**

There are only very few data available on CHR. Evaluation on short-term toxicity of CHR to aquatic invertebrates was reported as following in the Support Document for identification of CTPHT as SVHC (ECHA, 2009):

*The only study, that showed a considerable effect of chrysene, was a determination of the median lethal time of neonates of Daphnia magna (Newsted & Giesy, 1987). In this experiment, the daphnids were exposed to one concentration of chrysene (measured concentration of 0.7 µg/l). After 24 hours of exposure with a 16:8 h light:dark photoperiod, the animals were exposed to a mix of UV A , UV B and visible light. The median lethal time after UV-radiation started was 24 hours. Thus, after 48 hours, of which the last 24 hours were with UV irradiation, 50% mortality of the daphnids occurred at 0.7 µg/l. This type of study is however not designed to determine dose-response relationships and hence quantitative data on toxicity or toxicity threshold values cannot be derived from the result.*

#### **5.1.2.2 Long-term toxicity to aquatic invertebrates**

No standard test data on long-term toxicity to aquatic invertebrates are available.

There are only very few data available on CHR. Evaluation on long-term toxicity of CHR to aquatic invertebrates was reported as following in the Support Document for identification of CTPHT as SVHC (ECHA, 2009):

*The water solubility of chrysene is about 1.6 µg/l, with a range between 1.0 and 3.3 µg/l (Mackay et al., 2000). Around or below this value, no significant effects were observed for any species in a regular toxicity experiment, although chronic toxicity studies were performed with algae, crustaceans (including Daphnia) and fish.*

### **5.1.3 Algae and aquatic plants**

There are only very few data available on CHR. Evaluation on toxicity of CHR to aquatic algae was reported as following in the Support Document for identification of CTPHT as SVHC (ECHA, 2009):

*The water solubility of chrysene is about 1.6 µg/l, with a range between 1.0 and 3.3 µg/l (Mackay et al., 2006). Around or below this value, no significant effects were observed for any species in a regular toxicity experiment, although chronic toxicity studies were performed with algae, crustaceans (including Daphnia) and fish.*

## **5.2 Summary and discussion of the environmental hazard assessment**

The environmental hazard assessment for CHR was previously done for the identification of CTPHT as SVHC (ECHA, 2009). It is reported that "the only study, that showed a considerable effect of chrysene, was a determination of the median lethal time of neonates



*of Daphnia magna at a concentration of 0.7 µg/L (Newsted & Giesy, 1987). [...] This type of study is however not designed to determine dose-response relationships and hence quantitative data on toxicity or toxicity threshold values cannot be derived from the result."*

## **6. Conclusions on the SVHC Properties**

### **6.1 CMR assessment**

Chrysene is listed by index number 601-048-00-0 of Regulation (EC) No 1272/2008 in Annex VI, part 3, Table 3.1 (the list of harmonised classification and labelling of hazardous substances) and it is classified in the hazard class carcinogenicity category 1B (hazard statement H350: "May cause cancer").

Therefore, this classification of the substance in Regulation (EC) No 1272/2008 shows that it meets the criteria for classification in the hazard class:

- carcinogenicity category 1B in accordance with Article 57 (a) of REACH.

### **6.2 PBT and vPvB assessment**

#### **6.2.1 Assessment of PBT/vPvB properties**

The PBT/vPvB assessment is based on information provided in the support document for the identification of CTPHT as SVHC (ECHA, 2009). As additional information earlier assessments documented in the EU Risk Assessment Report on CTPHT (European Commission, 2008) and the Annex XV Transitional Dossier on CTPHT (NL, 2008) have been considered. The information summarised in these documents is still valid and allows a compact assessment of the substance properties with a focus on PBT/vPvB.

##### **6.2.1.1 Persistence**

CHR has a low water solubility and shows a high tendency to adsorb to particles and organic matter in the environment. The resulting low bioavailability is one of the limiting factors of its biodegradation.

A dissipation half-life of more than 8.1 years was measured in the filed study (Wild et al., 1991). The study by Wild et al. (1991) was selected as the study having highest weight for the P assessment. Additionally, the study by Wild et al. (1993) reports a half-life values of CHR in soil up to 313 days and is therefore above the P and vP criteria set in Annex XIII. Furthermore, model calculations done by Mackay et al. (1992) support that CHR is very persistent in the compartment soil and predicted that P and vP criteria are fulfilled for the compartments water and sediment.

Therefore it is concluded that CHR fulfils the P and vP criteria according to REACH Annex XIII. This conclusion was already drawn by the MSC in the context of the identification of CTPHT as SVHC (ECHA, 2009).

##### **6.2.1.2 Bioaccumulation**

An experimentally obtained BCF value above 5000 is reported for CHR in aquatic Crustacea. In accordance to REACH Annex XIII, CHR fulfils the B and vB criteria. This conclusion was already drawn by the MSC in the context of the identification of CTPHT as SVHC (ECHA, 2009). New data representative of lower trophic level also support the earlier conclusion. New data on fish bioaccumulation and trophic magnification in the field

showing lack of accumulation in higher trophic levels does not remove the concern on lower trophic levels.

#### 6.2.1.3 Toxicity

CHR is classified in the hazard class carcinogenicity category 1B according to EU Regulation 1272/2008. Thus, the T criterion of REACH Annex XIII section 1.1.3 b) is fulfilled.

### **6.2.2 Summary and overall conclusions on the PBT and vPvB properties**

#### Art 57 (d) and (e):

An assessment of the PBT/vPvB properties of CHR has already been carried out by the MSC in the context of the identification of CTPHT as SVHC, as documented in the MSC Support Document for identification of CTPHT as SVHC (ECHA, 2009). Additional information was assessed earlier in the EU Risk Assessment Report on CTPHT (European Commission, 2008) and the Annex XV Transitional Dossier on CTPHT (NL, 2008). Both reports support the conclusions on the PBT and vPvB properties of CHR already drawn in the MSC Support Document on CTPHT. The information leading to the identification of CTPHT as SVHC is still valid and allow compact assessment of the substance properties with a focus on PBT/vPvB.

#### Persistence

Based on the available information from experimental and estimated data, CHR degrades very slowly in soil with half-lives of > 180 d. Thus, the P and the vP criteria of REACH Annex XIII are fulfilled.

#### Bioaccumulation

The bioaccumulation of CHR in Crustacea were measured and BCFs > 5000 obtained. Thus, the B and the vB criteria of REACH Annex XIII are fulfilled.

#### Toxicity (only relevant for PBT substances)

CHR is classified in the hazard class carcinogenicity category 1B according to EU Regulation 1272/2008. Thus, the T criterion of REACH Annex XIII 1.1.3 b) is fulfilled.

#### Overall conclusion

In conclusion, chrysene meets the criteria for a PBT and vPvB substance according to Article 57 (d) and (e) of REACH based on weight-of-evidence determination and the criteria for carcinogenicity to Article 57 (a) of REACH Regulation.

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