

Assistance to the Commission on Technological Socio-Economic and Cost-Benefit Assessment Related to Exemptions from the Substance Restrictions in Electrical and Electronic Equipment:

Study to assess renewal requests for 29 RoHS 2 Annex III exemptions [no. I(a to e -lighting purpose), no. I(f - special purpose), no. 2(a), no. 2(b)(3), no. 2(b)(4), no. 3, no. 4(a), no. 4(b), no. 4(c), no. 4(e), no. 4(f), no. 5(b), no. 6(a), no. 6(b), no. 6(c), no. 7(a), no. 7(c) - I, no. 7(c) - II, no. 7(c) - IV, no. 8(b), no. 9, no. 15, no. 18b, no. 21, no. 24, no. 29, no. 32, no. 34, no. 37]

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07 June 2016

Report for The European Commission

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Acknowledgements:

We would like to express our gratitude towards stakeholders who have taken an active role in the contribution of information concerning the requests for exemption handled in the course of this project.

Disclaimer:

Eunomia Research & Consulting, Oeko-Institut and Fraunhofer Institute IZM have taken due care in the preparation of this report to ensure that all facts and analysis presented are as accurate as possible within the scope of the project. However no guarantee is provided in respect of the information presented, and Eunomia Research & Consulting, Oeko-Institut and Fraunhofer Institute IZM are not responsible for decisions or actions taken on the basis of the content of this report.

Executive Summary

Under Framework Contract no. ENV.C.2/FRA/2011/0020, a consortium led by Eunomia Research & Consulting was requested by DG Environment of the European Commission to provide technical and scientific support for the evaluation of exemption requests under the new RoHS 2 regime. The work has been undertaken by Oeko-Institut and Fraunhofer Institute IZM, and has been peer reviewed by Eunomia Research & Consulting.

E.1.0 Background and Objectives

The RoHS Directive 2011/65/EU entered into force on 21 July 2011 and led to the repeal of Directive 2002/95/EC on 3 January 2013. The Directive can be considered to have provided for two regimes under which exemptions could be considered, RoHS 1 (the former Directive 2002/95/EC) and RoHS 2 (the current Directive 2011/65/EU).

- The scope covered by the Directive is now broader as it covers all EEE (as referred to in Articles 2(1) and 3(1));
- The former list of exemptions has been transformed in to Annex III and may be valid for all product categories according to the limitations listed in Article 5(2) of the Directive. Annex IV has been added and lists exemptions specific to categories 8 and 9;
- The RoHS 2 Directive includes the provision that applications for exemptions have to be made in accordance with Annex V. However, even if a number of points are already listed therein, Article 5(8) provides that a harmonised format, as well as comprehensive guidance – taking the situation of SMEs into account – shall be adopted by the Commission; and
- The procedure and criteria for the adaptation to scientific and technical progress have changed and now include some additional conditions and points to be considered. These are detailed below.

The new Directive details the various criteria for the adaptation of its Annexes to scientific and technical progress. Article 5(1)(a) details the various criteria and issues that must be considered for justifying the addition of an exemption to Annexes III and IV:

- The first criterion may be seen as a threshold criterion and cross-refers to the REACH Regulation (1907/2006/EC). An exemption may only be granted if it does not weaken the environmental and health protection afforded by REACH;
- Furthermore, a request for exemption must be found justifiable according to one of the following three conditions:

- Substitution is scientifically or technically impracticable, meaning that a substitute material, or a substitute for the application in which the restricted substance is used, is yet to be discovered, developed and, in some cases, approved for use in the specific application;
- The reliability of a substitute is not ensured, meaning that the probability that EEE using the substitute will perform the required function without failure for a period of time comparable to that of the application in which the original substance is included, is lower than for the application itself;
- The negative environmental, health and consumer safety impacts of substitution outweigh the benefits thereof.
- Once one of these conditions is fulfilled, the evaluation of exemptions, including an assessment of the duration needed, shall consider the availability of substitutes and the socio-economic impact of substitution, as well as adverse impacts on innovation, and life cycle analysis concerning the overall impacts of the exemption; and
- A new aspect is that all exemptions now need to have an expiry date and that they can only be renewed upon submission of a new application.

The current study presented here, evaluates a total of 29 exemption renewal requests for existing exemptions approaching their expiry date.

E.2.0 Key Findings – Overview of the Evaluation Results

The exemption requests covered in this project and the applicants concerned, as well as the final recommendations and proposed expiry dates are summarised in Table 1-1. The reader is referred to the corresponding section of this report for more details on the evaluation results.

The – not legally binding – recommendations for the requests for the renewal of exemptions (29 RoHS 2 Annex III exemptions: no. I(a to e - lighting purpose), no. I(f - special purpose), no. 2(a), no. 2(b)(3), no. 2(b)(4), no. 3, no. 4(a), no. 4(b), no. 4(c), no. 4(e), no. 4(f), no. 5(b), no. 6(a), no. 6(b), no. 6(c), no. 7(a), no. 7(c) - I, no. 7(c) - II, no. 7(c) - IV, no. 8(b), no. 9, no. 15, no. 18b, no. 21, no. 24, no. 29, no. 32, no. 34, no. 37) were submitted to the EU Commission by Oeko-Institut and have already been published at the EU CIRCA website on 27 June 2016. So far, the Commission has not adopted any revision of the Annex to Directive 2011/65/EU based on these recommendations.

Exemption No.	Wording: Main Entry Sul	b-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
n. 1	Mercury in single fluorescent lamp burner):	e-capped (compact) os not exceeding (per		Mercury in single-capped (compact) fluorescent lamps not exceeding (per burner)		
a to e (lighting)	1(a) For general lighting purposes < 30 W: 5 mg 1(b) For general lighting purposes \geq 30 W and < 50 W: 5 mg 1(c) For general lighting purposes \geq 50 W and < 150 W: 5 mg 1(d) For generalNARVA Lichtquelle GmbH + Co. KG LightingEurope	NARVA Lichtquellen GmbH + Co. KG LightingEurope	(a) For general lighting purposes < 30 W: 2.5 mg (b) For general lighting purposes ≥ 30 W and < 50 W: 3.5 mg	For Cat. 8 and Cat. 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. industrial: 21 July 2024	The maximum transition period should be granted to other categories (18 months); The COM should consider adopting measures to limit product availability to B2B transactions.	
(lighting)		lighting purposes ≥ 150 W: 15 mg 1(e) For general lighting purposes with circular or square structural shape and tube diameter ≤ 17 mm: 7 mg		(c) For general lighting purposes ≥ 50 W and < 150 W: 5 mg (d) For general lighting purposes ≥ 150 W: 15 mg	For Cat. 5: 21 July 2019; For Cat. 8 and Cat. 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	

Table 1-1: Overview of the exemption requests, associated recommendations and expiry dates

Exemption No.	Wording: Main Entry Sub-Entry		Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
				(e) For general lighting purposes with circular or square structural shape and tube diameter ≤ 17 mm	7 mg may be used per burner until 31.12.2019, 5 mg may be used per burner after 31.12.2019 For Cat. 5: 21 July 2019 For Cat. 8 and Cat. 9: 21 July 2021 For Sub- Cat. 8 in-vitro: 21 July 2023 For Sub-Cat. 9 industrial: 21 July 2024	
				Mercury in single-capped (compact) fluorescent lamps not exceeding (per burner)		
f (special purpose)		1(f) For special purposes: 5 mg	NARVA Lichtquellen GmbH + Co. KG LightingEurope	(f)-I For lamps designed to emit light in the ultra-violet spectrum: 5 mg	For Cat. 5: 21 July 2021	The maximum transition period should be granted for other applications and other categories (18 months); Integrating this entry into a UV lamp exemption should be considered.

Exemption No.	Wording: Main Entry Sub-Entry		Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
				(f)-II For special purposes: 5 mg	For Cat. 8 and Cat. 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	The COM should consider adopting measures to limit product availability to B2B transactions.
n. 2 (a)	Mercury in double-capp fluorescent lamps for ge purposes not exceeding	oed linear eneral lighting J (per lamp):		Mercury in double-capped linear fluorescent lamps for general lighting purposes not exceeding (per lamp)		
	(1) Tri- with n and a 9 mm	i-band phosphor normal lifetime tube diameter < (e.g. T2): 5 mg		1) Tri-band phosphor with normal lifetime and a tube diameter < 9 mm (e.g. T2): 4 mg	For Cat. 5, 8 & 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	
(1-5)	(2) Tri- with n and a 9 mm (e.g. T (3) Tri- with n and a > 17 m (e.g. T (4) Tri- with n	i-band phosphor normal lifetime tube diameter \geq and \leq 17 mm (5): 5 mg i-band phosphor normal lifetime tube diameter nm and \leq 28 mm (8): 5 mg i-band phosphor normal lifetime	NARVA Lichtquellen GmbH + Co. KG LightingEurope	(2) Tri-band phosphor with normal lifetime and a tube diameter $\ge 9 \text{ mm}$ and ≤ 17 mm (e.g. T5): 3 mg (3) Tri-band phosphor with normal lifetime and a tube diameter > 17 mm and ≤ 28 mm (e.g. T8): 3.5 mg (4) Tri-band phosphor with normal lifetime and a tube diameter > 28 mm (e.g. T12): 3.5 mg	For Cat. 8 & 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	The maximum transition period should be granted for other applications and other categories (18 months);

Exemption No.	Wording: Main Entry Sub-Entry		Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
		and a tube diameter > 28 mm (e.g. T12): 5 mg (5) Tri-band phosphor with long lifetime (≥ 25 000 h): 8 mg		(5) Tri-band phosphor with long lifetime (≥ 25 000 h): 5 mg	For Cat. 5, 8 & 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	
				2(b) Mercury in other fluorescent lamps not exceeding (per lamp)		
n. 2 (b) (3)		(3) Non-linear tri-band phosphor lamps with tube diameter > 15 mm (e.g. T9)	NARVA Lichtquellen GmbH + Co. KG LightingEurope	(3) Non-linear tri-band phosphor lamps with tube diameter > 17 mm (e.g. T9)	For Cat. 5: 21 July 2019; For Cat. 8 & 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	
n. 2 (b) (4)		(4) Lamps for other general lighting and special purposes (e.g. induction lamps): 15 mg per lamp	LightingEurope	 (I) Lamps for other general lighting and special purposes (e.g. induction lamps); 15 mg may be used per lamp after 31 December 2011 	For Cat. 8 & 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	

Exemption No.	Wording: Main Entry Sub-Entry		Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
				(II) Lamps emitting light in the non-visible spectrum: 15 mg per lamp	For Cat. 5: 21 July 2021	Integrating this entry into a UV lamp exemption should be considered.
				(III) Emergency lamps: 15 mg per lamp	For Cat. 5: 21 July 2021	
				(IV) Mercury in other fluorescent special purpose lamps not specifically mentioned in this Annex: 15mg per lamp	For Cat. 5: 21 January 2019	
n.3	Mercury in cold lamps and extern fluorescent lamp special purposes lamp):	cathode fluorescent nal electrode os (CCFL and EEFL) for s not exceeding (per		Mercury in cold cathode fluorescent lamps and external electrode fluorescent lamps (CCFL and EEFL) for special purposes not exceeding (per lamp):		
		(a) Short length (\leq 500 mm): 3.5 mg per lamp (b) Medium length (> 500 mm and \leq 1 500 mm): 5 mg per lamp (c) Long length (> 1 500 mm): 13 mg per lamp lamp	LightingEurope	 (a) Short length (≤ 500 mm), 3,5 mg may be used per lamp; (b) Medium length (> 500 mm and ≤ 1 500 mm), 5 mg may be used per lamp; (c) Long length (> 1 500 mm) 13 mg may be used per lamp 	For Cat. 8 & 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	

Exemption No.	Wording: Main Entry Sub-	Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
				 (d) Short length (≤ 500 mm), 3,5 mg may be used per lamp in EEE placed on the market before 22 July 2016* (e) Medium length (> 500 mm and ≤ 1 500 mm), 5 mg may be used per lamp in EEE placed on the market before 22 July 2016* (f) Long length (> 1 500 mm) 13 mg may be used per lamp in EEE placed on the market before 22 July 2016* 	For Cat. 5: 21 July 2021	*Or before the EC's decision date on this exemptions renewal
				(g) For back-lighting liquid crystal displays, not exceeding 5 mg per lamp, used in industrial monitoring and control instruments placed on the market before 22 July 2017	Alternative a: For Cat. 5: 21 July 2021; or Alternative b: For Sub- Cat. industrial: 21 July 2024	To be considered should Ex. 35 of Annex IV be transferred to Annex III
n.4 (a)	Mercury in other I lamps (per lamp):	low pressure discharge 15 mg per lamp	NARVA Lichtquellen GmbH + Co. KG LightingEurope	4(a)-I: Mercury in low pressure non-phosphor coated discharge lamps, where the application requires the main range of the lamp-spectral output to be in the UV spectrum; up to 15 mg mercury may be used per lamp.	For Cat. 5: 21 July 2021	The maximum transition period should be granted for other applications and other categories (18 months);

Exemption No.	Wording: Main Entry Sul	b-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
				4(a)-II: Mercury in other low pressure discharge lamps (15 mg may be used per lamp)	For Cat. 8 and Cat. 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	
n.4 (b)	Mercury in High (vapour) lamps f purposes not ex lamps with impr index Ra > 60:	Pressure Sodium for general lighting ceeding (per burner) in oved colour rendering	LightingEurope	Mercury in High Pressure Sodium (vapour) lamps for general lighting purposes not exceeding (per burner) in lamps with improved colour rendering index Ra > 60:		
		I) P ≤ 155 W: 30 mg per burner		 (I) P ≤ 155 W; 30 mg may be used per burner (II) 155 W < P ≤ 405 W; 40 mg may be used per burner 	For Cat. 5, 8 & 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. industrial: 21 July 2024	
		 II) 155 W < P ≤ 405 W: 40 mg per burner III) P > 405 W: 40 mg per burner 		(III) P > 405 W; 40 mg may be used per burner	For Cat. 8 & 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	It is understood that these lamps are no longer placed on the market. Thus the exemption appears to have become obsolete, however is specified for Cat. 8 and Cat. 9 in light of Article 5(2).

Exemption No.	Wording: Main Entry Su	b-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
n.4 (c)	Mercury in othe (vapour) lamps f purposes not ex	r High Pressure Sodium for general lighting ceeding (per burner)		Mercury in other High Pressure Sodium (vapour) lamps for general lighting purposes not exceeding (per burner):		
		I) $P \le 155$ W: 25 mg per burner II) 155 W < $P \le 405$ W: 30 mg per burner III) $P > 405$ W: 40 mg per burner	LightingEurope	(I) $P \le 155$ W; 25 mg may be used per burner after 31 December 2011 (II) 155 W < $P \le 405$ W; 30 mg may be used per burner after 31 December 2011 (III) $P > 405$ W; 40 mg may be used per burner after 31 December 2011 (IV) $P \le 405$ W; 20 mg may be used per burner (V) $P > 405$ W; 25 mg may be used per burner	For Cat. 5: 31 August 2018; For Cat. 8 & 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024 For Cat. 5: from 1 September 2018 until 21 July 2021	
n.4(e)	Mercury in meta	al halide lamps (MH)	LightingEurope	Mercury in metal halide lamps (MH)	For Cat. 5, 8 & 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
n.4(f)			(I) Mercury in other discharge lamps for special purposes not specifically mentioned in this Annex	For Cat. 8 & 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. industrial: 21 July 2024	
	Mercury in other discharge lamps for special purposes not specifically mentioned in this Annex	VskE Lighting Europe VDMA	(II) Mercury in high pressure mercury vapour lamps used in projectors where an output ≥2000 lumen ANSI is required	For Cat. 5: 21 July 2021	
			(III) Mercury in high pressure sodium vapour lamps used for horticulture lighting	For Cat. 5: 21 July 2021	
			(IV) Mercury in lamps emitting light in the ultraviolet spectrum for curing and disinfection	For Cat. 5: 21 July 2021	
				For Cat. 5: 21 July 2021;	
n.5(b)	Lead in glass of fluorescent tubes not	LightingEuropo	Lead in glass of fluorescent	For Cat. 8 and Cat. 9: 21 July 2021;	
	exceeding 0,2 % by weight	сіўнішусці оре	tubes not exceeding 0,2 % by weight	For Sub-Cat. 8 in-vitro: 21 July 2023;	
				For Sub-Cat. 9 industrial: 21 July 2024	

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments	
n.6(a)	Lead as an alloying element in steel for machining purposes and in galvanised steel containing up to 0,35 % lead by weight		Dunkermotoren;	I) Lead as an alloying element in steel for machining purposes containing up to 0,35 % lead by weight	For Cat. 1-7 and 10 and 11: 21 July 2019	
		The European Steel Association (EUROFER) and European General Galvanizers	II) Lead in batch hot dip galvanized steel components containing up to 0.2% lead by weight	For Cat. 1-7 and 10 and 11: 21 July 2021		
			Association (EGGA) Sensata Technologies	III) Lead as an alloying element in steel for machining purposes and in galvanized steel containing up to 0,35 % lead by weight	For Cat. 8 and 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	
			Lead as an alloying element in aluminium			
n.6(b)	Lead as an alloying element in aluminium containing up to 0,4 % lead by weight	AISBL - EAA Sensata Technologies Dunkermotoren	I) with a lead content up to 0.4 % by weight, used for the production of parts not machined with shape cutting chipping technologies	For Cat. 1-7 and 10 and 11: 21 July 2021		
			II) for machining purposeswith a lead content up to 0.4% by weight	For Cat. 1-11: 21 July 2021		

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
			III) Lead as an alloying element in aluminium containing up to 0,4 % lead by weight	For Cat. 8 and 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	
n.6(c)	Copper alloy containing up to 4 % lead by weight	Bourns Inc. Dunkermotoren Framo Morat Group Sensata Technologies Phoenix Contact GmbH &Co KG; Harting KGaA Lighting Europe	Copper alloy containing up to 4% lead by weight	For Cat. 1-7 and 10 and 11: 21 July 2019; For Cat. 8 and 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	
n.7(a)	Lead in high melting temperature type solders (i.e. lead-based alloys containing 85 % by weight or more lead)	gh melting temperature type e. lead-based alloys containing veight or more lead) Bourns Inc. IXYS Semiconductor GmbH Chenmko Enterprise Co., Ltd Yeashin Technology Co., Ltd Freescale Semiconductor Formosa Microsemi Co., Ltd.	I) Lead in high melting temperature type solders (i.e. lead-based alloys containing 85 % by weight or more lead) Lead in high melting temperat	For Cat. 8 and 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024 cure type solders (i.e.	
			lead-based alloys containing 8 lead) II) in all applications not addressed in items III and IV,	5 % by weight or more For categories 1 to 7 and 10: 21 July 2021	See exemption report for alternative

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
			but excluding applications in the scope of exemption 24		wording proposal for 7(a)(II-IV).
			III) for die attach		
			IV) for electrical connections on or near the voice coil in power transducers	For categories 1 to 7 and 10: 21 July 2019	
El	 1.7(c)-I Belectrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound BanDELI GmbH&G Informat Technoloc Industrie Associati Murata E GmbH EPCOS A VISHAY E 	Bourns Inc. Sensata Technologies YAGEO Corporation RALEC TECHNOLOGY (KUNSHAN) CO. BANDELN electronic GmbH&Co.KG	7(c)-I: Electrical and electronic components containing lead in a ceramic other than dielectric ceramic in discrete capacitor components, e.g. piezoelectronic devices	For categories 1-7 and 10: 21 July 2019	See exemption report for alternative wording proposal for 7(c)-I
n.7(c)-l		GmbH&Co.KG RALEC TECHNOLOGY (KUNSHAN) CO. Japan Electronics & Information Technology Industries Association Murata Elektronik GmbH EPCOS AG	7(c)-V: Electrical and electronic components containing lead in a glass or in a glass or ceramic matrix compound. This exemption does not cover the use of lead in the scope of exemption 34 (cermet-based trimmer potentiometers).	For categories 1-7 and 10: 21 July 2021	See exemption report for alternative wording proposal for 7(c)-I

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
		components BEYSCHLAG GmbH SCHOTT AG	7(d): Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound	For Cat. 8 and 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	See exemption report for alternative wording proposal for 7(c)-l
n 7(c) II	Lead in dielectric ceramic in capacitors	Murata Elektronik GmbH EPCOS AG VISHAY BC components BEYSCHLAG GmbH	Lead in dielectric ceramic in capacitors for a rated voltage of 125 V AC or 250 V DC or higher	For Cat. 8 and 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	
n. /(c)-n	'(c)-II for a rated voltage of 125 V AC or 250 V BEYSCHLAG GmbH DC or higher JEITA(Japan Electronics & Information Technology Industries Association) Second	Lead in dielectric ceramic in discrete capacitor components for a rated voltage of 125 V AC or higher, or for a rated voltage of 250 V DC or higher	For Cat. 1-7 and 10: 21 July 2019		
n.7(c)-III	Recommended modified wording		Lead in dielectric ceramic in discrete capacitor components for a rated voltage of less than 125 V AC, or for a rated voltage of less than 250 V DC	1 January 2013 and after that date may be used in spare parts for EEE placed on the market before 1 January 2013	

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
n.7(c)-IV	Lead in PZT-based dielectric ceramic materials for capacitors which are part of integrated circuits or discrete semiconductors	ST Microelectronics	Lead in PZT-based dielectric ceramic materials of capacitors being part of integrated circuits or discrete semiconductors	For Cat. 1-7 and 10: 21 July 2019; For Cat. 8 and 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	
			8(b) Cadmium and its compounds in electrical contacts	For Cat. 8 and 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	
n.8(b)	Cadmium and its compounds in electrical contacts	National Electrical Manufacturers Association	8(c): Cadmium and its compounds in electrical contacts of (I) circuit breakers		
			(II) thermal motor protectors excluding hermetically sealed thermal motor protectors	For Cat. 1-7 and 10: 21 July 2021	

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
			(III) thermal sensing controls	For Cat. 1-7 and 10: 21 July 2019	
			(IV) AC switches rated at 6 A and more in combination with 250 V AC and more	Applies to <i>EEE</i> in Cat. 1 to 5, 7 and 10	
			(V) AC switches rated at 12 A and more in combination with 125 V AC and more	For Cat. 1 to 5, 7 and 10: 21 July 2019	
			(VI) AC switches for corded tools rated at 6 A and more in combination with 250 V AC and more		
			(VII) AC switches for corded tools rated at 12 A and more in combination with 125 V AC and more		
			(VIII) DC switches for cordless tools with a rated current of 20 A and more in combination with at a rated voltage of 18 V DC and more	21 July 2021	
			(IX) switches for tools conceived to be used with power supplies of 200 Hz and more		

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
n.9	Hexavalent chromium as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0,75 % by weight in the cooling solution	Dometic	Hexavalent chromium as an anticorrosion agent applied in carbon steel cooling systems of absorption refrigerators of applications: (I) designed to operate with electrical heater only, with up to 0,75 % by weight in the cooling solution (II) designed to operate with variable energy sources (III) designed to operate with other than an electrical heater	For Cat. 1: 21.7.2019 (three years)	
n.15	Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages	Intel Corporation	I) Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages	For Cat. 8 and 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
			II) Lead in solders to complete a viable electrical connection between semiconductor die and the carrier within integrated circuit flip chip packages where one of the below criteria applies:		
			a) A semiconductor technology node of 90 nm or larger	For categories 1-7 and 10: 21 July 2019	
			b) A single die of 300 mm ² or larger in any semiconductor technology node	For categories 1-7 and 10: 21 July 2021	
			c) Stacked die packages with dies of 300 mm ² or larger, or silicon interposers of 300 mm ² or larger	For categories 1-7 and 10: 21 July 2021	
			d) Flip chip on lead frame (FCOL) packages with a rated current of 3 A or higher and dies smaller than 300 mm ²		The exemption cannot be recommended but is added here in case the Commission would decide that it should be granted

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
n.18(b)	Lead as activator in the fluorescent powder (1 % lead by weight or less) of discharge lamps when used as sun tanning lamps containing phosphors such as BSP (BaSi 2 O 5 :Pb)	NARVA Lichtquellen GmbH + Co. KG Lighting Europe	Lead as activator in the fluorescent powder (1 % lead by weight or less) of discharge lamps containing phosphors such as BSP (BaSi2O5 :Pb), when used: I. in tanning equipment; or II. in Annex I category 8 medical phototherapy equipment - excluding applications falling under point 34 of Annex IV	For Cat. 5: 21 July 2021	
	Lead and cadmium in printing inks for		I. Cd when used in colour printed glass to provide filtering functions, used as a component in lighting applications installed in displays and control panels of EEE	For Cat. 1-7 and 10: 21 July 2021	The EU Commission should consider if it would not be more beneficial to add this entry to Ex. 13b.
n.21	such as borosilicate and soda lime glasses	Lighting Europe	II. Alternative A: Cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses, when used to comply with harmonised standards specifying the use of	For Cat. 1-7 and 10: 21 July 2021	The EU Commission could consider providing a shorter validity period so as to promote the supply chain to develop a strategy for research and

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
			particular hues for safety applications. Alternative B: Cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses, excluding Cd used in colour printed glass to provide filtering functions.		development of alternatives for Cd- based inks.
			III. Lead in printing inks for the application of enamels on other than borosilicate glasses.	For Cat. 1-4, 6,7 and 10: 21 July 2019	The recommended period should suffice to establish the reliability of Pb-free substitutes in other than borosilicate glasses.

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
			<i>IV. Lead and cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses</i>	For Cat. 8 and Cat. 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024;	As it can be understood that the exemption duration may vary for various categories on the basis of Article 5(2), expiration dates have been specified here on the basis of the validity periods specified in Article 5(2) for categories, which are newly in scope.
n.24	Lead in solders for the soldering to machined through hole discoidal and planar array ceramic multilayer capacitors	Knowles	Lead in solders for the soldering to machined through hole discoidal and planar array ceramic multilayer capacitors	For Cat. 1-7 and 10: 21 January 2019; For Cat. 8 and Cat. 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024;	

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
n.29	Lead bound in crystal glass as defined in Annex I (Categories 1, 2, 3 and 4) of Council Directive 69/493/EEC (1)	EUROPEAN DOMESTIC GLASS and LightingEurope	Lead bound in crystal glass as defined in Directive 69/493/EEC	For Cat. 1-10: 21 July 2021 For Sub-Cat. 8 in-vitro: 21 July 2023 For Sub-Cat. industrial: 21 July 2024	
n.32	Lead oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes	Coherent Inc. JDSU	Lead oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes	For Cat. 1-10: 21 July 2021 For Sub-Cat. 8 in-vitro: 21 July 2023 For Sub-Cat. industrial: 21 July 2024	
n.34	Lead in cermet-based trimmer potentiometer elements	General Electric	Lead in cermet-based trimmer potentiometers	For Cat. 1-7 and 10: 21 July 2019; For Cat. 8 and Cat. 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024;	

Exemption No.	Wording: Main Entry Sub-Entry	Applicant	Recommendation: Proposed Exemption Wording Formulation	Proposed Duration	Comments
n.37	Lead in the plating layer of high voltage diodes on the basis of a zinc borate glass body	IXYS Semiconductor GmbH General Electric	Lead in the plating layer of high voltage diodes on the basis of a zinc borate glass body	For categories 1-7 and 10: 21 July 2019; For Cat. 8 and 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024	

The report includes the following sections:

Section 1.0: Project Set-up

Section 2.0: Scope

Section 3.0: Links from the Directive to the REACH Regulation

Sections 4.0 through 34.0: Evaluation of the requested exemptions handled in the course of this project.

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1.0 Project Set-up

Assignment of project tasks to Oeko-Institut, started 29 December 2014. The overall project has been led by Carl-Otto Gensch. At Fraunhofer IZM the contact person is Otmar Deubzer. The project team at Oeko-Institut consists of the technical experts Yifaat Baron and Katja Moch. Eunomia, represented by Adrian Gibbs, have the role of ensuring quality management.

2.0 Scope

The scope of the project covers the evaluation of twenty-nine exemptions for which requests for renewal have been submitted to the European Commission. An overview of the exemption requests is given in Table 1-1 below.

In the course of the project, a stakeholder consultation was conducted. The stakeholder consultation was launched on 21 August 2015 and held for a period of 8 weeks, thus concluding on 16 October 2015.

The specific project website was used in order to keep stakeholders informed on the progress of work: <u>http://rohs.exemptions.oeko.info</u>. The consultation held during the project was carried out according to the principles and requirements of the European Commission. Stakeholders who had registered at the website were informed through email notifications about new steps within the project.

Information concerning the consultation was provided on the project website, including a general guidance document, the applicants' documents for each of the exemption requests, results of earlier evaluations where relevant, a specific questionnaire and a link to the EU CIRCA website. All non-confidential stakeholder comments, submitted during the consultation, were made available on the RoHS Evaluation website and on the EU CIRCABC website (Communication and Information Resource Centre for Administrations, Businesses and Citizens).¹

The evaluation of the stakeholder contributions led to further consultation including, inter alia, engaging with stakeholders in further discussion, further exchanges in order to clarify remaining questions, cross-checking with regard to the accuracy of technical arguments, and checks in respect of confidentiality issues. Meetings held in the context of the exemptions are detailed in the specific exemption reports.

¹ EU CIRCABC website: <u>https://circabc.europa.eu</u> (Browse categories > European Commission > Environment > RoHS 2014 Evaluations Review, at top left, click on "Library")

The exemptions requested for renewal were evaluated according to the various criteria (Cf. Section E.1.0 for details). The evaluations of each exemption appear in the following chapters. The information provided by the applicants and by stakeholders is summarised in the first sections. This includes a general description of the application and requested exemption (requested renewal or proposed amendment), a summary of the arguments made for justifying the exemption, information provided concerning possible alternatives and additional aspects raised by the applicants and other stakeholders. In some cases, reference is also made to information submitted by applicants and stakeholders in previous evaluations, in cases where a similar request has been reviewed or where a renewal has been requested of a request reviewed in the past. The Critical Review follows these sections, in which the submitted information is discussed, to clarify how the consultants evaluate the various information and what conclusions and recommendations have been made. For more detail, the general requirements for the evaluation of exemption requests may be found in the technical specifications of the project.²

² Cf. under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_8/RoHS_Pack8_Technical_specificat ions.pdf

3.0 Links from the Directive to the REACH Regulation

Article 5 of the RoHS 2 Directive 2011/65/EU on "Adaptation of the Annexes to scientific and technical progress" provides for the:

" inclusion of materials and components of EEE for specific applications in the lists in Annexes III and IV, provided that such inclusion does not weaken the environmental and health protection afforded by Regulation (EC) No 1907/2006".

RoHS 2 does not further elaborate the meaning of this clause.

Regulation (EC) No 1907/2006 regulates the safe use of chemical substances, and is commonly referred to as the REACH Regulation since it deals with **R**egistration, **E**valuation, **A**uthorisation and Restriction of **Ch**emical substances. REACH, for its part, addresses substances of concern through processes of authorisation and restriction:

- Substances that may have serious and often irreversible effects on human health and the environment can be added to the candidate list to be identified as Substances of Very High Concern (SVHCs). Following the identification as SVHC, a substance may be included in the Authorisation list, available under Annex XIV of the REACH Regulation: "List of Substances Subject to Authorisation". If a SVHC is placed on the Authorisation list, companies (manufacturers and importers) that wish to continue using it, or continue placing it on the market, must apply for an authorisation for a specified use. Article 22 of the REACH Regulation states that: *"Authorisations for the placing on the market and use should be granted by the Commission only if the risks arising from their use are adequately controlled, where this is possible, or the use can be justified for socioeconomic reasons and no suitable alternatives are available, which are economically and technically viable."*
- If the use of a substance (or compound) in specific articles, or its placement on the market in a certain form, poses an unacceptable risk to human health and/or to the environment that is not adequately controlled, the European Chemical Agency (ECHA) may restrict its use, or placement on the market. These restrictions are laid down in Annex XVII of the REACH Regulation: "Restrictions on the Manufacture, Placing on the Market and Use of Certain Dangerous Substances, Mixtures and Articles". The provisions of the restriction may be made subject to total or partial bans, or other restrictions, based on an assessment of those risks.

The approach adopted in this report is that once a substance has been included into the regulation related to authorization or restriction of substances and articles under REACH,

the environmental and health protection afforded by REACH may be weakened in cases where, an exemption would be granted for these uses under the provisions of RoHS. This is essentially the same approach as has already been adopted for the re-evaluation of some existing RoHS exemptions 7(c)-IV, 30, 31 and 40,³ as well as for the evaluation of a range of requests assessed through previous projects in respect of RoHS 2.⁴ Furthermore, substances for which an authorisation or restriction process is already underway are also reviewed, so that future developments may be considered where relevant.

When evaluating the exemption requests, with regard to REACH compliance, we have checked whether the substance / or its substitutes are:

- on the list of substances proposed for the adoption to the Candidate List (the Registry of Intentions);
- on the list of substances of very high concern (SVHCs- the Candidate List);
- in the recommendations of substances for Annex XIV (recommended to be added to the Authorisation List);
- listed in REACH Annex XIV itself (The Authorization List); or
- listed in REACH Annex XVII (the List of Restrictions).

As the European Chemicals Agency (ECHA) is the driving force among regulatory authorities in implementing the EU's chemicals legislation, the ECHA website has been used as the reference point for the aforementioned lists, as well as for the exhaustive register of the Amendments to the REACH Legal Text.

Figure 3-1 shows the relationship between the two processes and categories. Substances included in the red areas may only be used when certain specifications and or conditions are fulfilled.

³ See Zangl, S.; Blepp, M.; Deubzer, O. (2012) Adaptation to Scientific and Technical Progress under Directive 2011/65/EU - Transferability of previously reviewed exemptions to Annex III of Directive 2011/65/EU, Final Report, Oeko-Institut e. V. and Fraunhofer IZM, February 17, 2012, <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/Rohs_V/Re-</u> evaluations_transfer_RoHS_I_RoHS_II_final.pdf

⁴ Gensch, C., Baron, Y., Blepp, M., Deubzer, O., Manhart, A. & Moch, K. (2012) Assistance to the Commission on technological, socio-economic and cost-benefit assessment related to exemptions from the substance restrictions in electrical and electronic equipment (RoHS Directive), Final Report, Oeko-Institut e. V. and Fraunhofer IZM, 21.12.2012

http://rohs.exemptions.oeko.info/fileadmin/user_upload/Rohs_V/RoHS_V_Final_report_12_Dec_2012_final.pdf

Figure 3-1: Relation of REACH categories and lists to other chemical substances



The following bullet points explain in detail the above mentioned lists and where they can be accessed:

- Member States Competent Authorities (MSCAs) / the European Chemicals Agency (ECHA), on request by the Commission, may prepare Annex XV dossiers for identification of Substances of Very High Concern (SVHC), Annex XV dossiers for proposing a harmonised Classification and Labelling, or Annex XV dossiers proposing restrictions. The aim of the public Registry of Intentions is to allow interested parties to be aware of the substances for which the authorities intend to submit Annex XV dossiers and, therefore, facilitates timely preparation of the interested parties for commenting later in the process. It is also important to avoid duplication of work and encourage cooperation between Member States when preparing dossiers. Note that the Registry of Intentions is divided into three separate sections: listing new intentions; intentions still subject to the decision making process; and withdrawn intentions. The registry of intentions is available at the ECHA website at: <u>http://echa.europa.eu/web/guest/addressing-chemicals-ofconcern/registry-of-intentions;</u>
- The identification of a substance as a Substance of Very High Concern and its inclusion in the Candidate List is the first step in the authorisation procedure. The Candidate List is available at the ECHA website at <u>http://echa.europa.eu/web/quest/candidate-list-table</u>;
- The last step of the procedure, prior to inclusion of a substance into Annex XIV (the Authorisation list), involves ECHA issuing a Recommendation of substances for Annex XIV. The ECHA recommendations for inclusion in the Authorisation List are available at the ECHA website at

<u>http://echa.europa.eu/web/guest/addressing-chemicals-of-</u> <u>concern/authorisation/recommendation-for-inclusion-in-the-authorisation-list/authorisation-list;</u>

- Once a decision is made, substances may be added to the Authorisation List available under Annex XIV of the REACH Regulation. The use of substances appearing on this list is prohibited unless an Authorisation for use in a specific application has been approved. The Annex can be found in the consolidated version of the REACH Legal Text (see below);
- In parallel, if a decision is made concerning the Restriction on the use of a substance in a specific article, or concerning the restriction of its provision on the European market, then a restriction is formulated to address the specific terms, and this shall be added to Annex XVII of the REACH Regulation. The Annex can be found in the consolidated version of the REACH Legal Text (see below); and
- As of the 28 of September, 2015, the last amendment of the REACH Legal Text was dated from 28 May 2015 (Commission Regulation (EU) No 2015/830) and so the updated consolidated version of the REACH Legal Text, dated 01.06.2015, was used to check Annex XIV and XVII: The consolidated version is presented at the ECHA website: http://echa.europa.eu/web/guest/regulations/reach/legislation.

Relevant annexes and processes related to the REACH Regulation have been crosschecked to clarify:

- In what cases granting an exemption could "weaken the environmental and health protection afforded by Regulation (EC) No 1907/2006" (Article 5(1)(a), pg.1)
- Where processes related to the REACH regulation should be followed to understand where such cases may become relevant in the future;

In this respect, restrictions and authorisations as well as processes that may lead to their initiation, have been reviewed, in respect of where RoHS Annex II substances are mentioned (i.e. lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE).⁵

Compiled information in this respect has been included, with short clarifications where relevant, in Tables A.1-5, which appear in Appendix A.1.0.

The information has further been cross-checked in relation to the various exemptions evaluated in the course of this project. This has been done to clarify that the Article 5(1)(a) pg.1 threshold-criteria quoted above is complied with in cases where an

⁵ This review currently does not address the 4 phthalates, DEHP, BBP, DBP and DIBP, which according to Commission Delegated Directive (EU) 2015/863 of 31 March 2015, have been added to the Annex. Information regarding these substances shall be added in future reviews.

exemption is to be granted / its duration renewed/ its formulation amended/ or where it is to be revoked and subsequently to expire as an exemption. The considerations in this regard are addressed in each of the separate chapters in which the exemption evaluations are documented (Chapters 4.0 through 34.0) under the relevant section titled "*REACH Compliance – Relation to the REACH Regulation*" (Sections 4.5.1 through 34.4.1).

17.0 Exemption 5(b): "Lead in glass of fluorescent tubes not exceeding 0,2 % by weight"

Declaration

In the sections that precede the "Critical Review" the phrasings and wordings of stakeholders' explanations and arguments have been adopted from the documents provided by the stakeholders as far as required and reasonable in the context of the evaluation at hand. Formulations have been altered in cases where it was necessary to maintain the readability and comprehensibility of the text. These sections are based exclusively on information provided by applicants and stakeholders, unless otherwise stated.

Acronyms and Definitions

EEE	Electrical and Electronic Equipment
EoL	End of Life
LEU	LightingEurope
Pb	Lead
PbO	Lead oxide

17.1 Background

LightingEurope (LEU)⁴⁷⁴ has applied for the renewal of exemption 5(b) related to the presence of lead in the glass of discharge lamps. In the past, leaded glass used to contain ca. 20 % lead, added in the form of PbO for functional reasons in the production process. However lead is no longer added intentionally during lamp glass production. In principle lead in the glass of fluorescent tubes has successfully been phased out by the lighting industry several years ago. Nonetheless, recycled glass from end of life lamps is used

⁴⁷⁴ LEU (2015a), LightingEurope, Request to renew Exemption 5(b) under Annex III of the RoHS Directive 2011/65/EU Lead in glass of fluorescent tubes not exceeding 0.2 % by weight, submitted 15.1.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_5_b_/5_b_LE_RoHS_ _Exemption_Req_final.pdf

today in the manufacture of new glass tubes (e.g. discharge glass tubes). As this glass can contain differing amounts of lead, a maximum content of 0.2 % by weight lead may still be present in the glass of fluorescent lamps.

LEU thus requests the renewal of the exemption for use in lamps falling under Cat. 5, with the following wording formulation and for the maximum duration:

"Lead in glass of fluorescent tubes not exceeding 0.2 % by weight"

17.1.1 Amount of Lead Used under the Exemption

According to LEU⁴⁷⁵, the lead content in glass of fluorescent tubes can be up to 0.2% if recycling glass is used in the glass production process. The homogenous material is glass. Producers of lamp glass tubes are continuously monitoring the lead content in recycling glass. Regarding the amount of lead under the exemption, the applicant states:

"The amount of intentionally added substance entering the EU-28 market annually through application for which the exemption is requested: 0 tons. According to LightingEuropes' experience in average of all low pressure discharge lamps, the legal threshold of 0.1% wt in homogenous material glass is not exceeded.

Theoretically assuming a lead content of 500 ppm average, roughly estimated 25 tons of lead would enter the EU-28 market bound in lamp glass. Worst case would be 100 tons assuming an average content of 0.2%

(Basis of the rough estimation: ca 680 Mio fluorescent lamps put on the EU-28 market per year (Eurostat data for 2013), average 0,1 kg weight per lamp; ca. 75% average glass per lamp = 50.000 tons; hereof 0.05/0.2% lead)" 476

17.2 Description of Requested Exemption

The exemption covers lamp glass of fluorescent tubes. Fluorescent lamps are low pressure discharge lamps in the scope of RoHS Directive, addressed in Annex I as category 5 (lighting equipment). The lamp glass used in low pressure discharge lamps is mainly soda-lime glass (soft glass). It can be understood that though lead was used in the manufacture of lamp tube glass in the past for functional reasons, it was successfully phased out years ago and is no longer intentionally added in manufacture. It is however present in the tube glass of new discharge lamps in light of its presence as an impurity in recycled glass, originating from end-of-life (EoL) lamps. Such glass is used as a raw material in the manufacture process of new lamp glass. ⁴⁷⁷

LEU⁴⁷⁸ explains that fluorescent lamps have long lifetimes and that since the use of lead in the glass of fluorescent tubes was allowed in the EU until 2010 and is still allowed in

⁴⁷⁵ Op. cit. LEU (2015a)

⁴⁷⁶ Op. cit. LEU (2015a)

⁴⁷⁷ Op. cit. LEU (2015a)

⁴⁷⁸ Op. cit. LEU (2015a)

most countries outside the EU, e.g. in China, that lead-containing recycled glass will be available for a foreseeable long term, probably decades. This is especially valid if the lamp glass is produced outside the EU. Lead in the glass is on the other hand safe as it will not leave the glass matrix under any circumstance. The requested maximum content of lead is only slightly above the RoHS threshold limit for lead in homogenous materials.

In a later communication, LEU details that under the first RoHS Directive, coming into effect in 2006, the use of Pb in glass for fluorescent lamps was exempted. In the second edition, this exemption was restricted to 0.2%. Thus a significant reduction was realized, leading to the current situation that glass for fluorescent lamps is still diluted with a small amount of Pb, sometimes slightly higher than the RoHS restriction of lead above 0.1% by weight. Hence in the long term, a declining trend of installed lamps with lead-containing glass is expected. On the other hand the market for fluorescent lamps is decreasing, which could lead to higher amounts of lamps or lamp glass produced outside the EU. The rejection of the exemption could lead to the limitation of the use of recycled glass (from lamps coming from the market) in lamp glass production.⁴⁷⁹

17.3 Applicant's Justification for Exemption

Lead has been added in fluorescent lamp glass production for decades in the form of PbO. Use of lead glass in lamps was for a long time standard technology. Adding lead to the glass in the past allowed better processability in all steps of glass smelting and glass soldering, leading to lower failure rates. Due to changes in the production processes lead in glass could be phased out in Europe during the last 4-8 years. However, lead can be found in the glass matrix of newly manufactured low pressure discharge lamps, if lead-contaminated recycling glass is used for glass production. In such cases the glass tubes can be contaminated with minimum amounts of lead, so that the general RoHS limit of 0.1% limit can slightly be exceeded, up to 0.2%. Depending on the levels of lead in the recycled material, the contents of lead in new discharge tube glass may vary. Thus, LEU explains that, despite internal measurements that show that most lamps do not exceed the threshold of 0.1% in the glass, the current threshold of 0.2% by weight is still considered to be necessary to ensure compliance where the 0.1% level is exceeded.

The use of recycled glass is explained to significantly reduce the energy consumption of glass production (-30% for the recycled glass amount according to experience of a LightingEurope member company).⁴⁸⁰

As it can be understood that the use of lead in the manufacture of lamp glass is not regulated in all countries outside the EU, LEU was asked, how it can be guaranteed that the presence of unintentional Pb in lamps manufactured with non-EU glass lamp

⁴⁷⁹ LEU (2015b), Lighting Europe, Answers to 1st Questionnaire Exemption No. 5(b) (renewal request), submitted 28.8.2015, available under

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_5_b_/Ex_5_b_Lighti ngEurope_1st_Clarification_LE_Answers_20150828.pdf

⁴⁸⁰ Op. cit. LEU (2015a)

recyclate (which may have higher lead levels) is similar to levels in glass tube manufactured with EU recyclate, or is at least within the allowances addressed in Ex. 5(b). LEU⁴⁸¹ explained in this regard that each manufacturer must ensure RoHS conformity of products by suitable measures e.g. according EN50581:2012. This includes the glass components. This requirement to ensure conformity applies evenly to different parts, different materials, different components, etc. LEU elaborated that glass coming from different glass furnaces may have differences in composition due to the specific mix of cullet and raw material, but not regarding the presence of lead. In general new produced lamp glass in Europe is lead-free (i.e. lead is not intentionally added - consultants comment). Fluorescent lamps put on the EU market since September 2010 have to be made of lead-free glass. No systematic differences could be recognized by LEU members regarding the origin of the glass.

17.3.1 Possible Alternatives for Substitution

LEU ⁴⁸² states that there is no alternative. Lead in the glass of fluorescent tubes in amounts <0.2% has no intended or unintended function. It is a contaminant originating from the use of recycled glass as a raw material in glass production. There is no intended addition of lead or lead compounds other than in the form of recycled glass. However, manufacturers of lamp glass tubes use recycled glass in order to save resources and energy. The rejection of the exemption could lead to the limitation of the use of recycled glass for lamp glass production as well as to higher costs related to the use of recycled glass in lamp glass production could result in an increase in the number of random conformity checks necessary, especially for lamps imported from outside the EU. If quality controls would reveal batches of lamps exceeding 0.1% lead, these lamps would not be allowed to be marketed in the EU-28. These non-conforming batches would then be exported out of the EU-28 or would need to be scrapped (recycled) directly before the lamps are used if export is not possible or too expensive (repackaging).

17.3.2 Environmental Arguments

According to one source a reduction of energy consumption of 2.5% per every 10% of recycled glass is achieved (lamp glass production of LightingEurope member OSRAM GmbH, Augsburg, Germany). Typically in the OSRAM GmbH, Augsburg glass production plant, 30 - 40 % recycling glass is used. Technically (theoretically) a recycled glass content of up to 80% is estimated to be possible, though such high amounts require that the recycled glass is nearly identical to the manufactured glass. The source of recycled glass is therefore mainly glass from lamp recycling. The content of lead (as well as mercury) is normally measured regularly in the above mentioned plant. ⁴⁸³

⁴⁸¹ Op. cit LEU (2015b)

⁴⁸² Op. cit. LEU (2015a)

⁴⁸³ Op. cit. LEU (2015a)

LEU⁴⁸⁴ further explains that lamps are in the scope of EU Directives 2002/96/EC - WEEE and 2012/19/EU– WEEE Recast. All lamps need to be collected and recycled, regardless of the levels of lead in lamp glass. Take back systems are installed in all EU Member States to facilitate the collection and the proper handling of lamps at end-of-life (further details in the exemption renewal application dossier, but are not detailed here as they concern lamps in general and do not provide specific details as to the fate of lead from the glass of lamps.

17.3.3 Socio-economic Impact of Substitution

According to the applicant there are no health impacts expected, irrespective of the lead content being below 0.2% (as requested) or below 0.1% (the RoHS threshold for Pb), as the lead is bound in glass. In parallel, as the use of recycled glass reduces the use of virgin resources and the consumption of energy, an increase in direct production costs could be expected should the exemption be revoked.⁴⁸⁵

17.4 Stakeholder Contributions

A single contribution was made during the stakeholder consultation regarding Ex. 5(b). The Test and Measurement Coalition (TMC)⁴⁸⁶ includes the seven leading companies in the sector representing roughly 60% of the global production of industrial test and measurement products. It is TMCs' understanding that according to the RoHS Directive, the exemptions listed in Annex III and Annex IV for which no expiry date has been specified, apply to sub-category 9 industrial with a validity period of 7 years, starting from 22 July 2017. This is also said to be explained in the RoHS FAQ, p. 26 <u>http://ec.europa.eu/environment/waste/rohs_eee/pdf/faq.pdf</u>. TMC, thus does not interpret the current exemption evaluation related to package 9 to concern category 9 industrial equipment, for which the exemptions evaluated in pack 9 are understood to remain valid, and has thus not provided exemption specific information.

17.5 Critical Review

17.5.1 **REACH Compliance – Relation to the REACH Regulation**

Appendix A.1.0 of this report lists Entry 30 in Annex XVII of the REACH Regulation, stipulating that lead compounds shall not be placed on the market, or used, as substances, constituents of other substances, or in mixtures for supply to the general public. A prerequisite to granting the requested exemption would therefore be to

<u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_1_a-</u> e_/General_Contribution_Test___Measurement_Coalition_package_9_exemptions_20151016.pdf

⁴⁸⁴ Op. cit. LEU (2015a)

⁴⁸⁵ Op. cit. LEU (2015a)

⁴⁸⁶ TMC (2015), Test & Measurement Coalition, General comments related to RoHS exemption package 9, submitted 16.10.2015, available under

establish whether the intended use of lead in this exemption request might weaken the environmental and health protection afforded by the REACH regulation.

In the consultants' understanding, the restriction for substances under Entry 30 of Annex XVII does not apply to the use of lead in this application. Pb present as an impurity in the glass of lamps manufactured with recycled glass from EoL lamps, in the consultants' point of view is not a supply of a lead compounds as a substance, mixture or constituent of other mixtures to the general public. Pb is part of an article and as such, Entry 30 of Annex XVII of the REACH Regulation would not apply.

Entry 63 of Annex XVII also restricts the use of lead and its compounds. Its restriction in jewellery would not apply in the case of this exemption. Paragraph 7 restricts the use of lead above certain concentrations in in articles supplied to the general public, where these may be placed in the mouth by children during normal use. Paragraph 8(k) however excludes articles in scope of RoHS 2 from this restriction, which thus does not apply to this case.

No other entries, relevant for the use of lead in the requested exemption could be identified in Annex XIV and Annex XVII (status January 2015).

Based on the current status of Annexes XIV and XVII of the REACH Regulation, the requested exemption would not weaken the environmental and health protection afforded by the REACH Regulation. An exemption could therefore be granted if other criteria of Art. 5(1)(a) apply.

17.5.2 Scientific and Technical Practicability of Substitution, environmental arguments

From the available information it can be understood that the presence of lead in discharge lamp tube glass is a result of the use of recycled material originating from recycled lamps in the production of new lamp glass tubes. Lead is not added intentionally and in this sense a substitution does not require the provision of a specific function as such. Though discharge lamp tube glass could be manufactured without the use of recycled material (i.e., a possible form of substitution), this would result in a higher consumption of energy (as well as energy related emissions like greenhouse gas emissions) for the manufacture of the tube glass, as the manufacture of glass from primary material requires higher temperatures for the fusion of raw materials into glass. In this sense, it can be followed that revoking the exemption in favour of this potential substitute would result in a higher environmental impact. In parallel, it can be understood that impacts on health and or the environment related to the presence of lead in lamp tube glass would not be expected, as the lead is encapsulated in the glass and emissions leading to such impacts are not expected.

17.5.3 Stakeholder Contributions

The contribution submitted by TMC raises a legal question as to the availability of the current exemption to category 9 equipment. Regardless of TMCs claims as to the availability of Annex III exemptions to sub-category 9 industrial for 7 years starting in 22.7.2017, in the case of Ex. 5(b) the wording formulation limits its applicability to the

glass of fluorescent tubes. Fluorescent tubes are understood to be a product of the discharge lamp group, which can be used as a component in other equipment. As, stated by the applicant, this product is understood to fall under category 5 and not under Cat. 9. Thus from a practical perspective, in the consultants' opinion, sub-category 9 industrial equipment would not benefit from the exemption directly, though lamps benefiting from the exemption could be used in Cat. 9 equipment.

17.5.4 The Scope of the Exemption

In the consultants view the exemption could be limited to category 5. The applicant has stated that lamps benefiting from Ex. 5(b) fall under category 5 and in the consultants' view the exemption wording formulation excludes its availability to other EEE components when lamps are used in a specific EEE. Should discharge lamps be in use in equipment falling under categories other than category 5, they would still be understood to fall under Cat. 5 as a component of an EEE and would thus still benefit from the exemption as long as it would be valid. The reduction of the levels of Pb in lamp tube glass is a continuous process, affecting the glass of all lamps manufactured. The consultants thus expect this change to affect the glass of lamps evenly. In other words it is not expected that reduction in the level shall only affect lamps used in some EEE, but not others. Thus, differentiation between categories would not be relevant.

17.5.5 Conclusions

Article 5(1)(a) provides that an exemption can be justified if at least one of the following criteria is fulfilled:

- their elimination or substitution via design changes or materials and components which do not require any of the materials or substances listed in Annex II is scientifically or technically impracticable;
- the reliability of substitutes is not ensured;
- the total negative **environmental**, **health and consumer safety impacts** caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof.

LEU states that there is no substitute as such, however in the consultants view, manufacturing discharge lamp glass from primary materials comprises a valid substitute. According to the statements of LEU, there would also be no problem with the reliability of such glass, which is expected to have comparable performance to lamp glass with up to 0.2 % by weight lead.

However, the consultants can follow that discontinuing the use of recycled glass in the manufacture of lamp glass would create negative impacts in relation to the need to use more primary materials (where secondary ones are available) and more energy needed for smelting the glass. In this sense, the consultants conclude that though there may be alternatives in the form of manufacture from primary materials, such alternatives would create negative environmental impacts that arguably outweigh the benefits of this substitute.

17.6 Recommendation

It is understood that although substitutes may exist, their associated environmental costs would be higher than in the case where the exemption is renewed and a use of up to 0.2% by weight Pb in the glass of discharge lamp tubes is further allowed. In this sense, one of the Article 5(1)(a) criteria is understood to be fulfilled and the renewal of the exemption is thus understood to be justified.

It is further observed that the intention of the RoHS Directive restrictions is to reduce the contents of harmful substances in the waste stream and the impacts related thereto. This is evident for example from Recital 8 of the Directive, stating *"Restricting the use of those hazardous substances is likely to enhance the possibilities and economic profitability of recycling of waste EEE and decrease the negative impact on the health of workers in recycling plants"*. In the case of Pb in the glass of fluorescent tubes, its content, currently as an impurity resulting from the use of recycled lamp glass, is understood not to limit the recycling of such waste, nor the use of such recycled glass as a secondary resource.

As it can further be followed that the reduction of lead in recycled glass from EoL lamps is expected to occur only very gradually due to long product lifetimes, the consultants would further recommend extending the exemption for a further five years, in line with the duration limitations addressed in Article 5(2).

Though in light of Article 5(2), from a legal perspective, an exclusion of EEE falling under Cat. 8 and 9 from the scope of this exemption may not be possible, the consultants do not see an added benefit from the availability of the exemption to categories other than Cat. 5. In the consultants view, through its formulation, the exemption is already restricted to use in lamps, which fall solely under Cat. 5. Since lamps can be used as a component of other articles, restricting the exemption to this category should not create any disadvantage to manufacturers of products of other categories using discharge lamps as a component. In such cases the Cat. 5 exemption would still be applicable to such lamps used as a component in equipment other than Cat. 5. All the more so as the formulation of the exemption is not to change and it already limits its applicability to lamps which are understood to fall under Cat. 5. If Cat. 8 and Cat. 9 cannot legally be excluded from these exemptions; duration periods for these categories have been specified in the exemption formulation below.

Exemption 5(b)	Duration*
	For Cat. 5: 21 July 2021
Lead in glass of fluorescent tubes not exceeding 0,2 %	For Cat. 8 and Cat. 9: 21 July 2021
by weight	For Sub-Cat. 8 in-vitro: 21 July 2023
	For Sub-Cat. 9 industrial: 21 July 2024

Note: As it can be understood that the exemption duration may vary for various categories on the basis of Article 5(2), expiration dates have been specified here for certain categories on the basis of the validity periods specified in Article 5(2) for categories, which are newly in scope.

17.7 References Exemption 5b

LEU (2015a) LightingEurope, Request to renew Exemption 5(b) under Annex III of the RoHS Directive 2011/65/EU Lead in glass of fluorescent tubes not exceeding 0.2 % by weight, submitted 15.1.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_5 _b_/5_b__LE_RoHS_Exemption_Req_final.pdf

LEU (2015b) Lighting Europe, Answers to 1st Questionnaire Exemption No. 5(b) (renewal request), submitted 28.8.2015, available under

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_5 _b_/Ex_5_b_LightingEurope_1st_Clarification_LE_Answers_20150828.pdf

TMC (2015) Test & Measurement Coalition, General comments related to RoHS exemption package 9, submitted 16.10.2015, available under http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_1 _a-

e_/General_Contribution_Test___Measurement_Coalition_package_9_exemptions_2 0151016.pdf

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18.0 Exemption 6a: "Lead as an alloying element in steel for machining purposes and in galvanised steel containing up to 0,35 % lead by weight"

Declaration

In the sections that precede the "Critical Review" the phrasings and wordings of stakeholders' explanations and arguments have been adopted from the documents provided by the stakeholders as far as required and reasonable in the context of the evaluation at hand. Formulations have been altered in cases where it was necessary to maintain the readability and comprehensibility of the text. These sections are based exclusively on information provided by applicants and stakeholders, unless otherwise stated.

Acronyms and Definitions

11SMn30	Lead-free cutting steel containing high sulphur and also manganese
11SMn37	Same as 11SMn30 but with a higher Mn content
1215	Lead-free low carbon free cutting steel
12L14	Leaded low carbon free cutting steel
ECHA	European Chemicals Agency
EGGA	The European General Galvanizers Association
EEE	Electrical and Electronic Equipment
ELV	End-of-Life Vehicle
EUROFER	The European Steel Association
KEMI	Kemikalieinspektionen, the Swedish Chemicals Agency
MnS	Manganese(II)sulphide
NSSMC	Nippon Steel and Sumitomo Metal Corporation
Pb	Lead
tpa	Tonnes per annum
TMC	The Test & Measurement Coalition
WEEE	Waste of Electrical and Electronic Equipment

18.1 Background

Exemption 6a covers different uses of lead in steel: the use of lead added as an alloying element in steel for machining purposes and the presence of lead in galvanized steel.

According to the European Steel Association (EUROFER) and the European General Galvanizers Association (EGGA),⁴⁸⁷ lead is added to steel as a machinability enhancer for industrial production. Lead as an alloying element in steel for machining purposes has a lubrication effect that eases deep drilling and high speed operations. This kind of steel is also called free cutting or free machining steel. For the production of free cutting steels, lead provides a good hot workability.⁴⁸⁸

Galvanisation is the process of applying a protective zinc coating to steel in order to prevent corrosion. The most common form of galvanisation is hot dip galvanisation, where iron or steel articles are galvanised by dipping in a molten bath of zinc or zincalloy; a small amount of lead tends to be present in the zinc bath, and hence this the source of lead in the galvanised steel (as discussed further in Section 18.2). Hot dip galvanisation can be done in continuous or batch operation: In hot dip galvanization as a continuous process, the steel is continuously drawn through a bath with a liquid zinc alloy. Individual metal articles are hot dip galvanized by a process called batch galvanizing. Both the continuous and batch processes of hot-dip galvanizing result in a metallurgical bond between zinc and steel. The bonding region is an intermetallic compound, termed the "alloy layer".⁴⁸⁹ EGGA⁴⁹⁰ states that the presence of lead in the continuous galvanizing process is sufficiently low to meet the default requirement of 0.1% Pb. Therefore EUROFER and EGGA⁴⁹¹ propose to restrict the exemption to batch hot dip galvanised steel instead of all types of galvanised steel.

EUROFER and EGGA⁴⁹² with the support of a number of organizations have submitted a request for the renewal of the above mentioned exemption with the following wording formulation (the additional wording is underlined):

"Lead as an alloying element in steel for machining purposes and in <u>batch hot dip</u> galvanized steel items containing up to 0.35% lead by weight."

⁴⁸⁷ EUROFER and EGGA (2015a), European Steel Association (EUROFER) and European General Galvanizers Association (EGGA) (2015a), Original Application for Exemption Renewal Request, submitted 16.01.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/</u> Exemption_6_a_/Eurofer/6a_RoHS_Application_Form_6a_16012015-.pdf

⁴⁸⁸ According to EUROFER and EGGA (2015a and b), steel is being hot-rolled to the required size for a customer from a piece with a larger (as-cast) cross sectional area.

⁴⁸⁹ Gensch et al. (2009), Carl-Otto Gensch, Oeko-Institut e. V., et al. 20 February (2009), Adaptation to scientific and technical progress under Directive 2002/95/EC: Final Report. With the assistance of Stéphanie Zangl, Rita Groß, Anna Weber, Oeko-Institut e. V. and Otmar Deubzer, Fraunhofer IZM. <u>http://ec.europa.eu/environment/waste/weee/pdf/final_reportl_rohs1_en.pdf</u>

⁴⁹⁰ EGGA (2016), European General Galvanizers Association (EGGA) (2016), Answers to 3rd Clarification Questions, submitted 01.03.2016.

⁴⁹¹ Op. cit. EUROFER and EGGA (2015a)

⁴⁹² Op. cit. EUROFER and EGGA (2015a)
Besides the associations EUROFER and EGGA, two companies have submitted a renewal request, both referring to the use of lead as an alloying element in steel for machining purposes:

- Dunkermotoren⁴⁹³ a manufacturer of electric drives, uses lead based steel alloys in gear parts because of the improved machinability that is achieved by lead. Dunkermotoren requests an exemption period of at least 5 years to allow requalification. Dunkermotoren estimates that if a substitute were available 2 to 5 years would be needed for this purpose.
- Sensata Technologies Holland B.V.⁴⁹⁴ a manufacturer of sensor and control products purchases latching components within the tripping and actuation mechanism from the supply chain.⁴⁹⁵ Sensata⁴⁹⁶ generally refers to the function of lead in all alloys covered under Ex. 6 (steel, aluminium and copper) such as improved "micro-machining, electrical conductivity, galvanic corrosion resistance, mechanical relaxation, tribological behaviour etc.".

As for the history of the exemption, it has to be noted that when the RoHS 1 Directive was published in 2002, Exemption 6 covered lead as an alloying element in steels, aluminium and copper.⁴⁹⁷ After the last revision in 2009⁴⁹⁸, the exemption was split into three exemptions 6a, 6b and 6c in order to cover each alloy with a separate wording.

In the end-of-life vehicles (ELV) Directive 2000/53/EC, the corresponding exemption has been narrowed to refer only to batch hot dip galvanizing processes as a result of the last revision in 2008 and 2009.⁴⁹⁹ The current wording of ELV Annex II Exemption 1(a) is *"Steel for machining purposes and batch hot dip galvanised steel components containing up to 0,35 % lead by weight"*.

⁴⁹³ Dunkermotoren GmbH (2014), Dunkermotoren GmbH (2014), Original Application for Exemption Renewal Request, submitted 15.12.2014, English version available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_a_/DUnkermotore n/Ex_6a_Dunkermotoren_150806_Ausnahmeantrag_Stahl_englisch.pdf

⁴⁹⁴ Sensata Technologies (2015a), Sensata Technologies Holland B.V. (2015a), Original Application for Exemption Renewal Request, submitted 15.01.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_a_/Sensata_Techn ologies/6a_6b_6c_RoHS-Exemptions_Application-Format_Ex_6a_b_c_Pb_in_St_Al_Cu.pdf ⁴⁹⁵ Sensata Technologies (2015b), Sensata Technologies Holland B.V. (2015b), Answers to Clarification

⁴⁹⁵ Sensata Technologies (2015b), Sensata Technologies Holland B.V. (2015b), Answers to Clarification Questions, submitted 20.08.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Sensata/Ex_6a6_ b6c_Sensata_Questions_response_20150820.pdf

⁴⁹⁶ Op. cit. Sensata Technologies (2015a)

⁴⁹⁷ The wording of exemption 6 was as follows: "Lead as an alloying element in steel containing up to 0,35% lead by weight, aluminium containing up to 0,4% lead by weight and as a copper alloy containing up to 4% lead by weight"

⁴⁹⁸ Op. cit. Gensch et al. (2009)

⁴⁹⁹ Zangl et al. (2010), Stéphanie Zangl et al., Oeko-Institut; Otmar Deubzer, Fraunhofer IZM (2010), Adaptation to scientific and technical progress of Annex II to Directive 2000/53/EC (ELV) and of the Annex to Directive 2002/95/EC (RoHS), final report; 28 July 2010; <u>http://elv.exemptions.oeko.info/</u> <u>fileadmin/user_upload/Final_Report/Corr_Final_report_ELV_RoHS_28_07_2010.pdf</u>

18.1.1 Amount of Lead Used under the Exemption

Steel for machining purposes

In their renewal request, EUROFER and EGGA⁵⁰⁰ estimate the amount of substance entering the EU market annually through applications for which the exemption is requested as follows:

"Machining steels – in 2013 the import of steel products for machining purposes amounted to approximately 73,000 tons. Assuming that the lead content in steel for machining purposes is between 0,2 and 0,35%, this means that the lead annually entering in the EU market through the import of free cutting steels can vary between 146 to 255 tons. However, note that these figures do not correspond solely to steel intended for EEE (which was not possible to estimate) and that also contains the volumes of steel intended for automotive."

During a 2nd round of clarification questions, EUROFER was asked to specify the production volume of leaded steel in the EU and to estimate the share of the total amount of leaded steel in the EU used for EEE by indicating at least a range of the amount of leaded steel in the EU used for EEE.⁵⁰¹ However, EUROFER⁵⁰² did not provide any further information.

The following estimations have been made during the last revision of the exemption:⁵⁰³

"The main production countries of leaded steels are UK, Germany, France and Spain. The total production volume of leaded steel in the EU is estimated to be 1,3 Mt per year. It is, however, not possible to accurately say how much of this material is used for applications covered by RoHS due to the length of supply chains and sales to stock-holders and intermediate processors selling steels to different applications. Within EEE, leaded steels are mainly used in larger equipment with smaller volumes. Therefore, yearly quantities are expected to be some tons at maximum."

As for the other applicants of renewal requests, Dunkermotoren does not provide information on the amount of lead in the production of the engine and transmission parts (gear parts), whereas Sensata⁵⁰⁴ estimates the amount of lead in the predefined components supplied to Europe to be less than 1kg.

⁵⁰⁰ Op. cit. EUROFER and EGGA (2015a)

⁵⁰¹ In analogy to the REACH registration, the following tonnage ranges were proposed: < 100 tonnes per annum (tpa); 100 - 1.000 tpa; 1.000 - 10.000 tpa; 10.000 - 100.000 tpa; 100.000 - 1.000.000 tpa. ⁵⁰² EUROFER (201()) European Steel Association (EUROFER) (201()) Approximate 2nd Clarification Outpation

⁵⁰² EUROFER (2016), European Steel Association (EUROFER) (2016), Answers to 2nd Clarification Questions, submitted 15.01.2016.

⁵⁰³ Op. cit. Gensch et al. (2009)

⁵⁰⁴ Op. cit. Sensata Technologies (2015a)

Galvanized steel

EUROFER and EGGA⁵⁰⁵ estimate the amount of lead intentionally added *" for applications in the scope of WEEE/ROHS"* to be less than 1 tonne per year. They further state not to be able to estimate the amount of unintentional lead in the recycled zinc (see Section 18.3.2. for further details).

18.2 Description of Requested Exemption

Steel for machining purposes

According to EUROFER and EGGA,⁵⁰⁶ lead is added as an alloying element in steel in order to enhance machinability *"if a variety of machining operations is required or if deep drilling of material is required"*. EUROFER and EGGA further explain that lead acts as a lubricant and thereby provides *"a reduced cutting force when machining steel, appropriate chip formation (length and force), facilitation of a smooth surface finish, facilitation of a good dimensional achievement under commercial production conditions or reduced <i>"tool wear" during the machining operation"* are of relevance.

EUROFER and EGGA are not able to provide an exhaustive list of EEE applications or of application sub-groups for which such steel is applied. EUROFER and EGGA⁵⁰⁷ explain that the problem is a result of the long and complex supply chain "*with many different actors, including stockists and intermediate processors. The producer of the free cutting steel itself rarely has detailed, if any, contact with the final EEE producer (or even the producer of the components that become part of EEE)."*

_EGGA_EUROFER_MCchanges15-9-15_revised.pdf

A number of organizations supported this compilation of information: European General Galvanizers Association (EGGA); European Steel Association (EUROFER); European Partnership for Energy and the Environment (EPEE); Digital Europe; Information Technology Industry Council (ITI); European Garden Machinery Industry Federation (EGMF); European Passive Components Industry Association (EPCIA); European Semiconductor Industry Association (ESIA); Japan Business Council in Europe (JBCE); Japan Business Machine and Information System Industries Association (JBMIA); Japan Electronics and Information Technology Industries Association (JEITA); Japan Electrical Manufacturers' Association (JEMA); Knowles UK Ltd.; LIGHTINGEUROPE; WirtschaftsVereinigung Metalle (WVM); German Electrical and Electronic Manufacturers' Association (ZVEI); European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry (COCIR); American Chamber of Commerce to the EU (AmCham EU); European Committee of Domestic equipment Manufacturers (CECED).

⁵⁰⁵ Op. cit. EUROFER and EGGA (2015a)

⁵⁰⁶ Op. cit. EUROFER and EGGA (2015a)

⁵⁰⁷ EUROFER and EGGA (2015b), European Steel Association (EUROFER) and European General Galvanizers Association (EGGA) (2015b), Answers to Clarification Questions, revised version, submitted 15.09.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_a_/Eurofer/Ex_6a_ Eurofer_1st_round_of_Clarification-Questions_final-20150803_DRAFT_REPLY_-

Instead, EUROFER and EGGA⁵⁰⁸ provide the following list of typical components: fuel injector systems, hydraulic clips, keys, motor shafts, fasteners, printer shafts, and a wide range of office equipment parts – for example lap top screen screws.

Galvanized steel

Lead is present in the zinc coating of batch hot dip galvanised steels, but does not provide a function in the coated product.⁵⁰⁹

According to the EUROFER and EGGA⁵¹⁰, lead in galvanised steel is mostly unintentionally present as an impurity related to the use of recycled zinc. EGGA⁵¹¹ explains that the unintentional lead content arises from the remelting of zinc metal from the crude galvanizers ashes (arising from oxidation of the zinc bath surface) and secondly from the recovery and recycling of scrap metallic zinc from roofing/gutters (often of 50 – 120 year vintage) made from former standard zinc grades with lead impurities⁵¹² that additionally contain lead-based solders that were used to join roofing sheets and gutters.

EUROFER and EGGA⁵¹³ state that lead is intentionally added in the galvanizing bath to adjust the viscosity and reach optimal drainage of excess zinc "*in a small number of plants*". According of EUROFER and EGGA,⁵¹⁴ the intentional addition of lead to the galvanizing bath is rapidly declining due to technical innovation.

According to EUROFER and EGGA⁵¹⁵, batch galvanized steel is used in components like fasteners, brackets, fixings *" for a range of EEE items such as lighting units that require high levels of durability in outdoor or aggressive environments"* as well as in e.g. transformer housings and heat exchangers.

18.3 Applicant's Justification for Exemption

Steel for machining purposes

EUROFER and EGGA⁵¹⁶ argue that lead provides an excellent machinability in a variety of machining processes such as e.g. turning, drilling, tapping, parting, grooving which is favourable especially in cases where the manufacturing of an EEE component requires a combination of different machining operations.

EUROFER and EGGA further argue not to be able to provide an exhaustive list of functionalities respective of performance aspects of lead because "'machinability' cannot be restricted to a property of the machined material. It is not a single material

⁵⁰⁸ Op. cit. EUROFER and EGGA (2015b)

⁵⁰⁹ Op. cit. Gensch et al. (2009)

⁵¹⁰ Op. cit. EUROFER and EGGA (2015a)

⁵¹¹ Op. cit. EGGA (2016)

⁵¹² So-called 'Good Ordinary Brand' / 'Prime Western' zinc.

⁵¹³ Op. cit. EUROFER and EGGA (2015a)

⁵¹⁴ Op. cit. EUROFER and EGGA (2015a)

⁵¹⁵ Op. cit. EUROFER and EGGA (2015b)

⁵¹⁶ Op. cit. EUROFER and EGGA (2016a)

property like tensile strength, ductility or electrical conductivity, which we can measure and have one value to characterize the material." Instead machinability depends also on the "material of the tool, the geometry of the tool, the machining operation itself (turning, drilling...), the machine type (autolathes, machines for specific applications, single spindle, multispindle...), the machining parameters, the cooling conditions. All these parameters have an influence on tool life, chip form, process forces and surface quality. This means it is a sum of chemical, mechanical and tribological properties which cannot be examined with a simple statistical correlation. The combination of various machining operations with a set of different tools in one machine is an additional difficulty. In this case one single operation can be the limiting factor for the whole machining process of a special part."

The other applicants Dunkermotoren and Sensata provide the following justifications:

- Dunkermotoren⁵¹⁷ argues with increased costs because the use of alternative material would increase the production time and shorten tool life.
- Sensata⁵¹⁸ who uses latching components within the tripping and actuation mechanism made from leaded steel argues that "the Sensata supply chain for lead-containing steel alloys comprises companies whose expertise is in stamping and screw-machining. Neither Sensata nor the Sensata supply chain has the expertise or resources to develop alternatives to leadcontaining steel alloys. For this reason the focus of the efforts made by Sensata has been on existing materials, none of which has proven to be a suitable replacement."

Galvanized steel

EGGA⁵¹⁹ explains that lead influences certain aspects of the process such as fluidity, drainage and ease of removal of dross for recycling. EUROFER and EGGA⁵²⁰ cannot give an estimation on the share of hot dip galvanization that still needs the intentional addition of lead. EGGA⁵²¹ explains that "there are no other limitations on the use of lead in the galvanizing process and the proportion of components coated that are within the scope of the WEEE directive is very small in volume terms. Decisions on the intentional use of lead or the use of recycled zinc would not be solely influenced by the processing of EEE-related components." EGGA further states that EEE normally represents a very small proportion of a plant's throughput.

⁵¹⁸ Op. cit. Sensata Technologies (2015b)

⁵²¹ Op. cit. EGGA (2016)

⁵¹⁷ Op. cit. Dunkermotoren (2015)

⁵¹⁹ Op. cit. EGGA (2016)

⁵²⁰ Op. cit. EUROFER and EGGA (2015b)

18.3.1 **Possible Alternatives for Substituting RoHS Substances**

Steel for machining purposes

In their application, EUROFER and EGGA⁵²² confirm that the steel mills are continuously researching, searching for new alternatives in order to find efficient substitutes to avoid the use of lead in steel. However they state that "no alternatives have been identified that can effectively replace lead as a machinability enhancer in steel in all respects. Leadfree alternatives may show acceptable results in single machinability tests, but the overall performance of the lead-free steels is worse than that of leaded steel. The lack of hot workability of the lead-free alternatives is also an important obstacle towards the substitution".⁵²³

EUROFER and EGGA⁵²⁴ mention the following possible alternatives that each shows certain disadvantages according to EUROFER and EGGA:

- Lead-free alternatives from Nippon Steel and Sumitomo Metal Corporation are used for the manufacture of printer rails. EUROFER and EGGA⁵²⁵ explain that printer rails are surface quality critical and are manufactured using very low feed rates. Initial problems related to built-up edge formation⁵²⁶ on the cutting tool have been solved by new developments of the steel that contains finer inclusions of Manganese(II)sulfide (MnS).⁵²⁷ EUROFER and EGGA⁵²⁸ are not aware of a wider use then printer rails.
- A lead-free development of the steel grade C45 by Toyota is mentioned; however, EUROFER and EGGA⁵²⁹ explain that a research project in 2005⁵³⁰ tested deep hole drilling applications and complex machine features where this leadfree development failed; EUROFER and EGGA conclude that it would therefore not be applicable for EEE.

⁵²² Op. cit. EUROFER and EGGA (2015a)

⁵²³ Op. cit. EUROFER and EGGA (2015a)

⁵²⁴ Op. cit. EUROFER and EGGA (2015b)

⁵²⁵ Op. cit. EUROFER and EGGA (2015b)

⁵²⁶ The so called "built-up edge" is a formation of metal deposits sticking to the tool close to the cutting edge. It can be observed usually at low cutting speeds, which causes chips to be torn away rather than cleanly cut, resulting in rough part surface, and it may damage the tool. Low cutting speed favour the formation of built-up edge as well as other cutting parameters such as e.g. large depth of cut.

See e.g. https://www.researchgate.net/post/How does the built-up edge lead to surface damage. ⁵²⁷ Hashimura M. et al (2007), Hashimura M., Miyanishi, K., Mizuno, A. (2007), Development of Low-Carbon Lead-Free Free-Cutting Steel Friendly to Environment, Nippon Steel Technical Report, No. 96, 2007. http://www.nssmc.com/en/tech/report/nsc/pdf/n9608.pdf 528 Op. cit. EUROFER and EGGA (2015b)

⁵²⁹ Op. cit. EUROFER and EGGA (2015b)

⁵³⁰ P.E. Reynolds et al. (2005), Technically and commercially viable alternatives to lead as machinability enhancers in steel used for automotive component manufacture, Report EUR 21912, Office for Official Publications of the European Communities, Luxembourg, 2005.

- There is also lead-free steel with a higher quantity of sulphur in free cutting steels, so called resulfurized steel grades. According to EUROFER and EGGA,⁵³¹ they showed "disappointing" results compared to leaded steel in deep drilling operations or high speed machining, due to decreased machining speed, increased tooling wear and an increased fragility and reduction in hot workability which results in yield losses. EUROFER and EGGA⁵³² do not provide further details on this statement.
- As for the alternatives with bismuth, increased sulphur (with and without tellurium), tin (with low and high copper), phosphorus and calcium, EUROFER and EGGA⁵³³ refer to results that already have been presented in the frame of the ELV Directive review of exemptions in 2008 and that are included in the corresponding report of Oeko-Institut.⁵³⁴

In brief, "Although the machining properties of bismuth-treated steels approach those of lead-treated steels for certain machining operations, in the majority of machining operations lead remains the most effective machinability additive through its wide range of machining characteristics. It was further concluded in the report that calcium can substitute lead in C45 steels for use at higher cutting speeds. However, calcium treated steels require higher cutting forces, have poorer chip form and have their best performance limited to a narrower range of machining speeds in comparison with the leaded product. The more limited benefits of calcium treated grades may not be able to match the benefits of leaded grades in many instances since it is very likely that a large variety of machining operations are required for many engineering components. Steels containing tin generally did not show good performance in the machinability tests and thus, was not considered as a suitable replacement for lead in steel."

EUROFER and EGGA⁵³⁵ also state that the lead-free alternatives that contain bismuth or tellurium show a decreased hot workability in the temperature range normally used for hot rolling of steel. According to EUROFER and EGGA,⁵³⁶ bismuth containing steel needs to be rolled at very high temperatures and often rolled material shows surface cracks like those shown in the following figures. EUROFER and EGGA⁵³⁷ explain that tellurium causes similar cracks.

⁵³¹ Op. cit. EUROFER and EGGA (2015a)

⁵³² Op. cit. EUROFER and EGGA (2015a)

⁵³³ Op. cit. EUROFER and EGGA (2015a)

⁵³⁴ Op. cit. Zangl et al. (2010)

⁵³⁵ Op. cit. EUROFER and EGGA (2016a)

⁵³⁶ Op. cit. EUROFER and EGGA (2016a)

⁵³⁷ Op. cit. EUROFER and EGGA (2016a)

Figure 18-1: Cracks in bismuth containing steel wire rods after rolling

Source: EUROFER (2016a)

As for bismuth containing steel, the following new efforts are reported:⁵³⁸ "Since 2010, this steel producer has carried out seven interconnected full scale trials related to the use of bismuth as an alternative to lead. During the last trial in 2012, a new 10MnSBi grade of steel (1215Bi) was manufactured under normal production conditions and supplied to customers. [...] The results from this and previous trials have indicated that bismuth steels are much more prone to surface break-up than normal leaded steels and the associated yield losses are not sustainable for routine production. [...]

Overall the results of these trials confirm the conclusions from the collaborative ECSC project where bismuth was shown to be a potential alternative to lead for the purposes of enhancing machinability but that low hot ductility and limited availability (of Bi) could prevent the material being a feasible commercial product."

Generally, EUROFER and EGGA⁵³⁹ raise concerns over the availability of bismuth and a higher price because bismuth production is most often a by-product of lead or tungsten production.

Galvanized steel

The research that EUROFER and EGGA mention for galvanizing processes do not deal with substitution of lead as it is mostly inadvertently present due to recycling of zinc scrap and galvanizers' ashes because the use of lead within the process have largely (but not completely) been replaced by other techniques, according to EUROFER and EGGA.⁵⁴⁰ EGGA⁵⁴¹ explains that the general research approach targets to reach thinner coatings regardless of steel type (*"more zinc-efficient coatings"*) and coatings of more consistent

⁵³⁸ Op. cit. EUROFER and EGGA (2015b)

⁵³⁹ Op. cit. EUROFER and EGGA (2015b)

⁵⁴⁰ Op. cit. EUROFER and EGGA (2015a)

⁵⁴¹ Op. cit. EGGA (2016)

appearance and surface finish. EGGA argues that this goes hand in hand with a general "desire to reduce the presence of hazardous substances, including lead. Intentional use of lead is now limited to a narrow, but important, set of processes and products." The problem that these processes cannot be separately dealt with is explored in Section 18.5.6.

18.3.2 **Possibilities for Reducing RoHS Substances**

Steel for machining purposes

EUROFER and EGGA⁵⁴² report a recent collaborative project between Saarstahl and Tata Steel on the question whether the 0.35% threshold of lead in steel can be reduced. According to EUROFER and EGGA,⁵⁴³ Tata Steel and Saarstahl produced several casts of low carbon free cutting steels with Pb contents from 0.11% up to 0.35%.

The machinability of the steel with different lead content was tested by producing a component on a single spindle automatic lathe using high speed steel tools under neat oil coolant and determining the maximum production rate than can be achieved. The tests showed "*progressive deterioration in machinability*" due to decreased tool life (see Figure 18-2) and higher cutting forces (see Figure 18-3), which result in either increased usage of cutting tools or longer machining times.



Figure 18-2: Tool wear by free cutting steels with different Pb content

Source: EUROFER and EGGA (2015b)

⁵⁴² Op. cit. EUROFER and EGGA (2015b)

⁵⁴³ Op. cit. EUROFER and EGGA (2015b)

Figure 18-3: Cutting forces (CF) and feed forces (FF) of free cutting steels with different Pb content in dry cutting conditions (left: 100 m/min, right: 130 m/min)



Galvanized steel

EUROFER and EGGA⁵⁴⁴ expect the lead content within recycled zinc arising from scrap roofing/gutters to decrease in the long term " (> ~50 years due to the very long product *life*)", as a result of "*new solders*" being used. Also, customer-driven requirements for lower lead levels in markets outside EEE/ELV and the higher price of lead than zinc (affecting intentional use) might also result in lower lead levels in time.

EGGA⁵⁴⁵ states "There may be a downward trend in lead content from sources from galvanizers' ashes associated with a general trend to avoid the intentional use of lead additions to the galvanizing bath. Recyclers estimate that will be >50 years before the lead content of recycled zinc from scrap metallic zinc from roofing/gutters shows any significant decline."

18.3.3 Environmental Arguments

Steel for machining purposes

EUROFER and EGGA⁵⁴⁶ specify processes where the scrap coming from machining of free cutting steel is recycled and the lead recovered by off gas treatment to 90%. EUROFER and EGGA do not provide information on the steel recycling circuit.

Besides this, EUROFER and EGGA raise the following environmental arguments, however without providing further evidence in both cases:

- EUROFER and EGGA⁵⁴⁷ mention as "wider environmental implications of material choice" that "the lower energy consumption of machining leaded

⁵⁴⁴ Op. cit. EUROFER and EGGA (2015b)

⁵⁴⁵ Op. cit. EGGA (2016)

⁵⁴⁶ Op. cit. EUROFER and EGGA (2015a)

⁵⁴⁷ Op. cit. EUROFER and EGGA (2015a)

steels means that there is a potential benefit of reduced electricity consumption and CO₂ emissions in fabrication": According to EUROFER and EGGA,⁵⁴⁸ " the addition of lead into low carbon free cutting steels enhances machinability and can increase the production rate of a component by up to 40% depending upon part and machining process design, and a potential reduction in energy usage of approximately 27% when machining parts using the leaded steel are compared to the non-leaded steel."

As for bismuth containing steel, EUROFER⁵⁴⁹ claims that "the high rolling" temperatures and a second or even third rolling process will cause additional energy consumption."

Galvanized steel

For galvanized steel, EUROFER and EGGA⁵⁵⁰ bring forward the argument in favour of using scrap zinc for galvanizing purposes:

"A life-cycle comparison of the embodied energy of (i) remelt secondary zinc and (ii) primary zinc has been published in 'Sachbilanz Zink', Prof. J. Krüger, Institut für Metallhüttenkunde und Elektrometallurgie der RWTH Aachen (ISBN 3-89653-939-6, 2001). This publication reports that: "The energy required for the extraction of zinc from scrap to obtain alloys capable of further use demands a primary energy input of only approximately 2.5 GJ/t. During the extraction of zinc from ores, the primary energy requirement for mining and ore dressing is around 5-9 GJ/t metal content in the concentrate. Concentrate processing to obtain a pure metal however calls for a primary energy input of 46-48 GJ/t zinc. Based on this information, the use of remelt secondary zinc reduces the embodied energy of the zinc used in batch galvanizing by over 20 times.""

18.3.4 Socio-economic Impact of Substitution

No information has been submitted on socio-economic effects of substitution by EUROFER and EGGA. As for general economic impacts, EUROFER and EGGA mention the following, but without providing further evidence to substantiate or quantify their claims: EUROFER and EGGA argue that an increasing demand for bismuth might result in a strong rise in the bismuth price and consequently an increase in production costs.⁵⁵¹

⁵⁴⁸ Op. cit. EUROFER and EGGA (2015a)

⁵⁴⁹ Op. cit. EUROFER (2016a)

⁵⁵⁰ Op. cit. EUROFER and EGGA (2015a) ⁵⁵¹ Op. cit. EUROFER and EGGA (2015b)

18.3.5 Road Map to Substitution

Steel for machining purposes

EUROFER and EGGA⁵⁵² do not provide a road map for substitution because substitutes in machining steel would need to first show the same level of hot workability as lead-containing free cutting steel, which has not occurred so far with the identified alternative materials.

Besides, EUROFER⁵⁵³ explains that the huge diversity of applications in (often small) different machining companies and the diversity of parameters in the system "machining" makes it very difficult to provide a timeframe for the substitution.

Galvanized steel

EUROFER and EGGA⁵⁵⁴ do not provide a road map because the inadvertent presence of Pb in the recycling chain does not demand substitution and the intentional addition of lead cannot be separated for the purpose of the production of EEE, which is explained to account for only a small portion of production (see Section 18.5.6).

18.4 Stakeholder Contributions

Six contributions to Exemption 6a have been submitted during the stakeholder consultation. The contributions are presented in order of submission and shortly summarized:

- The **Robert Bosch GmbH**⁵⁵⁵ generally supports the applicants without providing further information.
- **JBCE**⁵⁵⁶ Japan Business Council in Europe in a.i.b.l. states that they understand that EEE of Category 8 and 9 are out of scope of this review. The JBCE understands that " the exemption 6(a) in annex III can be applied to category 8&9 products for seven years from identified date when entry into force for each products, at the earliest July 2021."
- CETEHOR, the technical department of the Comite Franceclat (French Watch, Clock, Jewellery, Silverware & Tableware Centre)⁵⁵⁷ generally states the better

Exemption 6 a /Comment on public cousulation of Exemption request 2015-2 6 a ...pdf ⁵⁵⁷ CETEHOR (2015), Contribution by Comite Franceclat (French Watch, Clock, Jewellery, Silverware &

Tableware Centre), CETEHOR, submitted 15.10.2015, available under:

⁵⁵² Op. cit. EUROFER and EGGA (2015a)

⁵⁵³ Op. cit. EUROFER (2016)

⁵⁵⁴ Op. cit. EUROFER and EGGA (2015a)

⁵⁵⁵ Robert Bosch GmbH (2015), Contribution by Robert Bosch GmbH, submitted 15.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_a_/Bosch-</u> <u>Stakeholder-contribution-Exemption-request-6a.pdf</u>

⁵⁵⁶ JBCE (2015), Contribution by JBCE – Japan Business Council in Europe in a.i.b.l, submitted 15.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/</u>

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_a_/Ex_6_a_Comite _Franceclat_Cetehor_20151012.pdf

machinability of leaded steel with a lead content of 0.2%; a greater weal tool with unleaded steel would hinder a profitable manufacturing "in a severe context of competition with low-cost labour countries" and the longer machining cycles would increase energy consumption. CETEHOR claims to use a leaded steel with a lead content of 0.2%; therefore "the regulatory limit could be reduced to 0.3% to allow alloy suppliers to guarantee conformity to the regulatory value." CETEHOR⁵⁵⁸ estimates a quantity of lead of 1 kg per year based on the average amount of 1 g of machining steel per watch movement, a maximum lead content of this steel of 0.2% and the annual French production of guartz watches of 0.5 million.

- **KEMI** Kemikalieinspektionen, the Swedish Chemicals Agency⁵⁵⁹, recommends to " split into a number of more specific exemptions, related to applications where it has been verified that feasible alternatives are not currently available" and argues that the "broad and unspecific wording does not conform with the requirements in the updated RoHS Directive 2011/65/EU any longer". KEMI lists the specific applications provided by the applicants: Electric drives, engines and transmission parts (gear parts), latching components within the tripping and actuation mechanism, fuel injection systems, hydraulic clips, keys, motor shafts, printer shafts, lap top screen screws and the following articles manufactured in batch galvanised processes fasteners and support brackets/fixings in lighting units that require high levels of durability in outdoor or aggressive environment, transformer housings and heat exchangers.
- **PennEngineering**, ⁵⁶⁰ a designer and manufacturer of specialty fasteners, ⁵⁶¹ objects the renewal request because they have substituted lead-free cutting steel with "traditional grades of low carbon, rephosphorized, resulfurized, free machining steels" by applying "changes to tool materials and other subtle proprietary changes to minimize the loss of efficiency".

PennEngineering requests a transition period of more than 18 months because of the "significant inventory of steel fasteners with up to 0.35 % lead content in the distribution channels" and because "customers will stop accepting non-compliant product many months before it becomes non-compliant".

PennEngineering states that they currently use 907 t ("2,000,000 lb") of leaded steel per annum globally; the amount of the contained lead is calculated at 2.3

⁵⁵⁸ Op. cit. CETEHOR (2015)

⁵⁵⁹ KEMI (2015), Contribution by KEMI Kemikalieinspektionen, Swedish Chemicals Agency, submitted 19.10.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_a_/Ex_6a_KEMI_A nswer_to_SC_RoHS_20151016_Lead_in_Steel.pdf 560 PennEngineering (2015), Contribution by PennEngineering, submitted 19.10.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_a_/Ex_6a_PennEng ineering Consultation Questionnaire PE_AS_20151016.pdf ⁵⁶¹ For fasteners used in EEE, see at <u>http://www.pemnet.com/fastening_products/pdf/kdata.pdf</u>

tpa ("5,000 lb"). PennEngineering estimated that approximately 25% of their sales of leaded products go towards EEE in the EU.

The **Test & Measurement Coalition**⁵⁶² (TMC) submitted a general contribution on Category 9 Industrial monitoring and control instruments similar in its nature to that of JBCE.

18.5 Critical Review

18.5.1 **REACH Compliance – Relation to the REACH Regulation**

Appendix A.1.0 of this report lists Entry 30 in Annex XVII of the REACH Regulation, stipulating that lead and its compounds shall not be placed on the market, or used, as substances, constituents of other substances, or in mixtures for supply to the general public. A prerequisite to granting the requested exemption would therefore be to establish whether the intended use of lead in this exemption request might weaken the environmental and health protection afforded by the REACH regulation.

In the consultants' understanding, the restriction for substances under Entry 30 of Annex XVII does not apply to the use of lead in this application as lead is used as an alloying element. In the consultants' point of view it is not a supply of lead as a substance, mixture or constituent of other mixtures to the general public. Pb is part of an article and as such, Entry 30 of Annex XVII of the REACH Regulation would not apply.

Appendix A.1.0 of this report lists Entry 63 in Annex XVII of the REACH Regulation, stipulating that lead and its compounds shall not be placed on the market or used in articles supplied to the general public, if the concentration of lead (expressed as metal) in those articles or accessible parts thereof is equal to or greater than 0,05 % by weight, and those articles or accessible parts thereof may, during normal or reasonably foreseeable conditions of use, be placed in the mouth by children.⁵⁶³ Entry 63 however further specifies this restriction not to be applicable for articles within the scope of the RoHS Directive 2011/65/EU.

No other entries, relevant for the use of lead in the requested exemption could be identified in Annex XIV and Annex XVII (status January 2016).

Based on the current status of Annexes XIV and XVII of the REACH Regulation, the requested exemption would not weaken the environmental and health protection afforded by the REACH Regulation. An exemption could therefore be granted if other criteria of Art. 5(1)(a) apply.

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_1_ae /General Contribution Test Measurement Coalition package 9 exemptions 20151016.pdf ⁵⁶³ Other restrictions of entry 63 cover e.g. jewellery and are thus not applicable here.

⁵⁶² Test & Measurement Coalition (2015), Contribution by Test & Measurement Coalition, submitted 19 October 2015, available under

18.5.2 Scientific and Technical Practicability of Substitution

Steel for machining purposes

The basic problem for assessing the scientific and technical practicability of substitution of leaded steel is the fact that the applicant EUROFER as an association of steel producers does not have information on the detailed machining procedures. Therefore, EUROFER was not able to provide an exhaustive list of applications nor to specify in which EEE applications available alternative material might be practicable and reliable.

Nippon Steel and Sumitomo Metal Corporation were contacted to gain more information on their lead-free steel development. Nippon Steel and Sumitomo Metal Corporation⁵⁶⁴ state that they are supplying the material in the Asian market, however unfortunately not in Europe at this moment. They indicated that their lead-free steel is used for *"printer shafts, pins and small parts for automobile and industrial machines"*, which are produced by many different companies, and confirm that these components are also applicable in EEE. It has to be noted that printer shafts are among the typical components that require leaded steel according to EUROFER and EGGA.⁵⁶⁵ The following figure shows machine intensive application examples provided by NSSMC.⁵⁶⁶

Figure 18-4: Application examples of the lead-free steel developed by NSSMC



Source: Nippon Steel and Sumitomo Metal Corporation (NSSMC) (2016)

The lead-free steel by NSSMC⁵⁶⁷ is resulfurised free cutting steel; the hardness is stated to be almost equivalent to that of other low-carbon free cutting steels; it has a higher

- ⁵⁶⁵ Op. cit. EUROFER and EGGA (2015b)
- ⁵⁶⁶ NSSMC (2016), Nippon Steel and Sumitomo Metal Corporation (2016), Information submitted by email, 08 January 2016.
- ⁵⁶⁷ Op. cit. Hashimura M. et al (2007)

 ⁵⁶⁴ NSSMC (2015), Nippon Steel and Sumitomo Metal Corporation (2015), Information submitted by email,
 07 December 2015.

sulphur content and contains MnS which is distributed in very fine particles through controlled manufacturing conditions. NSSMC⁵⁶⁸ indicated the following chemical composition of their lead-free cutting steel (Figure 18-5).

		Chemical composition(mass%)					MnS
		С	Mn	Р	S	Pb	control
SAE Leaded free cutting steel	12L14	≦0.15	0.85 -1.15	0.04 -0.09	0.26 -0.35	0.15 0.35	_
JIS Leaded free cutting steel	SUM24L	≦0.15	0.85 -1.15	0.04 -0.09	0.26 -0.35	0.10 -0.35	_
NSSMC Lead free free cutting steel	Sumigreen CS	≦0.15	0.90 ~1.70	0.04 ~0.09	0.40 ~0.70	-	Spindle shaped
	EZ	≦0.15	0.90 ~1.30	0.07 ~0.12	0.35 ~0.60	-	Fine dispersed

Figure 18-5: Chemical composition of the lead-free free cutting steel developed by NSSMC

Source: Nippon Steel and Sumitomo Metal Corporation (NSSMC) (2016)

Nippon Steel and Sumitomo Metal Corporation⁵⁶⁹ estimate that the application of their lead-free steel does not require large process changes but some modifications of the cutting conditions. NSSMC⁵⁷⁰ estimates that the adaptations could comprise changes in the material and/or design of cutting tool, cutting speed, feeding speed, depth of cut, oil etc. NSSMC further estimates that the application of their lead-free steel does not require large investment costs but is not able to determine the costs. NSSMC⁵⁷¹ states that the cost of their lead-free steel approaches the same as leaded free cutting steel.

The contribution by PennEngineering shows that plant-specific adaptations in the machining procedures makes it possible to use lead-free steel grades that are available on the market: PennEngineering⁵⁷² is a designer and manufacturer of specialty fasteners.⁵⁷³ It has to be noted that fasteners are one of the typical components that according to the application of EUROFER and EGGA⁵⁷⁴ needs the use of leaded steel.

⁵⁶⁸ Op. cit. NSSMC (2016)

⁵⁶⁹ Op. cit. NSSMC (2016)

⁵⁷⁰ Op. cit. NSSMC (2016)

⁵⁷¹ Op. cit. NSSMC (2016)

⁵⁷² Op. cit. PennEngineering (2015a)

⁵⁷³ <u>http://www.pemnet.com/comp_lit_files/</u>, see bulletin K for fasteners used in EEE.

⁵⁷⁴ Op. cit. EUROFER and EGGA (2015b)

PennEngineering⁵⁷⁵ states that they have started to test lead-free free cutting steel "over three years ago" (as of October 2015). For environmental and strategic reasons,⁵⁷⁶ PennEngineering focused on "traditional grades of low carbon, rephosphorised, resulfurised, free machining steels", such as 1215, 11SMn30, and 11SMn37, that are commercially available in the small bar sizes PennEngineering uses.⁵⁷⁷ PennEngineering states that for most of our product, these grades can be run at the same surface footage and feed rates as 12L14 leaded steel with some reduction in efficiency: "In the majority of cases the decreased efficiency is from more frequent tool changes driven by faster deterioration of the surface finish. We are making changes to tool materials and other subtle proprietary changes to minimize the loss of efficiency." PennEngineering⁵⁷⁸ explains that the machining is done on five and six spindle automatic screw machines that perform a variety of machining operations.⁵⁷⁹

PennEngineering states that they managed the increased cost of the machining operation down to the area of 10%. However, PennEngineering did not reveal details of the technical changes in order to protect the *"significant investment in preparing for the eventual removal of RoHS Exemption 6a"*.

Besides the above mentioned examples of lead-free free cutting steel covering resulfurized (NSSMC) and rephosphorized and resulfurized (PennEngineering) steel grades, there are basically also lead-free alternatives available that contain bismuth or tellurium.⁵⁸⁰ EUROFER and EGGA⁵⁸¹ state that *"bismuth alloyed low carbon free cutting steels have been supplied for certain applications."* However, EUROFER and EGGA do not further specify these applications with *"very specific machining conditions"* but rather claim that this alternative is not practicable due to the above mentioned difficulties in hot workability. It might be that the difficulties in how workability cause negative environmental impacts by increased energy costs in the steel production; however in the absence of detailed comparisons, the consultants cannot conclude on this statement.

⁵⁷⁵ Op. cit. PennEngineering (2015a)

⁵⁷⁶ "We are well aware that other elements such as bismuth, selenium, tellurium, tin and calcium have been used to replace lead. Off these, bismuth, selenium and tellurium are the most commercially viable. Because environmental legislation is constantly changing, and because there are some environmental concerns with selenium and tellurium, we stayed away from steels with these two elements out of concern about future restrictions. We are still open to bismuth steels, but there are concerns about price and availability of bismuth."

⁵⁷⁷ According to PennEngineering (2015b), "round bar in the 5/32 inch to 5/8 inch range and hex bar in the 3/16 inch to 5/16 inch range".

⁵⁷⁸ Op. cit. PennEngineering (2015b)

⁵⁷⁹ Most commonly performed machining operations are rough forming, finish forming, turning, shaving, knurling, facing, cut off, drilling, form tapping, back working (primarily countersinking). Other machining operations also performed include reaming, slotting, broaching and external threading (primarily rolling with some cutting).

⁵⁸⁰ Op. cit. EUROFER and EGGA (2015a)

⁵⁸¹ Op. cit. EUROFER and EGGA (2015b) and (2016b)

It is apparent from the paragraphs above that there are alternatives on the market that are scientifically and technically practicable for at least some applications: This is the case for resulfurised and rephosphorised and resulfurised steel grades; for bismuth or tellurium containing steel, the information is not conclusive.

These single cases are not reflected by EUROFER and EGGA as it seems that they rather search for an all-round alternative: "*No alternatives have been identified that can effectively replace lead as a machinability enhancer in steel in all respects. Lead-free alternatives may show acceptable results in single machinability tests, but the overall performance of the lead-free steels is worse than that of leaded steel.*" Though the consultants understand this statement from a perspective of the steel producer, the example of PennEngineering shows that substitution efforts are successful when undertaken in the specific manufacturing case with different alternatives available.

The consultants understand that there might be components that require a combination of different machining operations and therefore that the machinability over a broad range of cutting parameters has to be guaranteed, which might only be provided by leaded steel. However these cases have to be specified in the future. If steel manufacturers or OEMs lack sufficient information to specify these aspects, they should embark on dialogue and joint investigation with the component manufacturers who are expected to be aware of modifications needed to allow workability with lead-free alloys. This need of a different approach is supported by the statement of EUROFER and EGGA⁵⁸² already mentioned above that the supply chain is complex and that the steel producer has limited, if any, contact to the final OEM producer. EUROFER⁵⁸³ states that *"the steel producer has a direct contact usually only to the bright drawer. In some special cases there are contacts also with the final producer (e.g. Bosch) for the discussion of special properties. But this is not the case for the commodity products." The supply chain of free cutting is illustrated in the following figure.*

 ⁵⁸² Op. cit. EUROFER and EGGA (2015b)
 ⁵⁸³ Op. cit. EUROFER (2016b)

Figure 18-6: Supply chain of free cutting steel



Source: EUROFER (2016b)

To conclude, the consultants understand from the information provided by EUROFER and EGGA that the steel producers are not able to provide the detailed information on the specific applications of leaded steel in the EEE sector that would be needed to assess the technical and scientific practicability of available substitutes. NSSMC confirm this estimation by stating that "*NSSMC do not know the detailed machining procedure*".

The supply chain provided by EUROFER in the figure above points out that the machining companies might be the right stakeholders for providing more precise information. It is understood from the example of PennEngineering that alternative materials might need adaptations in the machining procedures, which every EEE component manufacturer has to carry out for his specific machining operations; however, substitution at least for some applications is understood to be possible.

Galvanized steel

As the intentional addition of lead in the galvanizing process cannot be separated from the unintentional presence due to the use of zinc scrap and galvanizers' ashes, substitution of lead is not further discussed. For further information, please see section 18.5.6.

18.5.3 Possibilities for Reducing RoHS Substances

Steel for machining purposes

EUROFER and EGGA reported tests conducted by Tata Steel and Saarstahl according to which a reduction of lead in steel for machining purposes results in a decrease of production rate which subsequently caused an increased usage of cutting tools and/or longer machining times. The following figure shows this overall result according to EUROFER and EGGA. It is however unclear if attempts were made by Tata Steel and Saarstahl to adjust the processing to accommodate the decreasing lead content materials tested. This makes it difficult to assess the overall conclusion of EUROFER and EGGA on the *"progressive deterioration in machinability"*: Are longer machining times acceptable in some applications? Which possibilities can be explored to minimize the loss of efficiency as in the case of PennEngineering?



Figure 18-7: Effect of Pb reduction in steel alloy on production rate in a component production test

The consultants can follow that steel with a lower lead content may suffer technical drawbacks for e.g. machining in automated series production. There might, however, be applications where a reduction of lead does not pose a significant problem as the contribution of CETEHOR shows, where generally leaded steel with a lead content of 0.2% is used. It might be that the required level of performance cannot be generally defined but depends on the machining processes. However, where substitution with lead-free alloys is not possible, the second approach in the future strategy of companies could be to apply lower leaded steel in their applications where a complete phase-out is not practical.

Galvanized steel

The consultants' understand the lead in the batch hot dip galvanization is expected to slightly decrease in the future due to different reasons such as reduction of intentional addition of lead, decrease of lead in the galvanizers' ashes together with decrease in the very long term (50 years and more) of lead in recycled zinc scrap.

Source: EUROFER & EGGA (2015b)

18.5.4 Environmental Arguments

Steel for machining purposes

EUROFER and EGGA raise general environmental arguments on higher energy use of alternative material due to lower production rate in the components manufacturing⁵⁸⁴ or higher temperature needed in the steel production.⁵⁸⁵ Though those differences may be of relevance, available information does not allow a comprehensive comparison in this respect. Especially for comparison of the energy use in the component manufacturing, it is expected that this could be case specific and dependent on adaptations in the machining conditions, which helps to reduce the efficiency loss shown in the case of PennEngineering. However, it might be that the energy savings could support the exemption for specific applications if it is comprehensively documented.

Galvanized steel

It is understood that the introduction of lead is unintentional and merely a result of lead being present in the secondary zinc. From an environmental perspective, the consultants can follow that the recycling of zinc scrap and its reuse is a positive practice, as it enables a reuse of ressources and as stated by EUROFER and EGGA⁵⁸⁶ this is understood to be more energy efficient than the use of primary zinc: *" the use of remelt secondary zinc reduces the embodied energy of the zinc used in batch galvanizing by over 20 times"*⁵⁸⁷ (see section 18.3.3).

18.5.5 Stakeholder Contributions

Six contributions were submitted to the stakeholder consultation. The contributions of KEMI,⁵⁸⁸ CETEHOR⁵⁸⁹ and PennEngineering⁵⁹⁰ are discussed in the sections above as well as below. Bosch⁵⁹¹ did not provide any evidence to its claims; therefore the contribution was not further considered.

The contributions submitted by TMC⁵⁹² and JBCE⁵⁹³ raise a legal question as to the availability of the current exemption to category 8 and 9 equipment. TMC and JBCE claim the availability of Annex III exemptions to category 8 and 9 for seven years starting in 22.7.2017. EUROFER and EGGA⁵⁹⁴ state in this regard:

⁵⁸⁷ Op. cit. EUROFER and EGGA (2015a)

⁵⁸⁴ Op. cit. EUROFER and EGGA (2015a)

⁵⁸⁵ Op. cit. EUROFER (2016a)

⁵⁸⁶ Op. cit. EUROFER and EGGA (2015a)

⁵⁸⁸ Op. cit. KEMI (2015)

⁵⁸⁹ Op. cit. CETEHOR (2015)

⁵⁹⁰ Op. cit. PennEngineering (2015a)

⁵⁹¹ Op. cit. Bosch (2015)

⁵⁹² Op. cit. TMC (2015)

⁵⁹³ Op. cit. JBCE (2015)

⁵⁹⁴ Op. cit. EUROFER and EGGA (2015a)

"We apply for renewal of this exemption for categories 1 to 7, 10 and 11 of Annex I for an additional validity period of 5 years. For these categories, the validity of this exemption may be required beyond this timeframe. Although applications in this exemption renewal request may be relevant to categories 8 & 9, this renewal request does not address these categories. Further, categories 8 & 9 have separate maximum validity periods and time limits for application for renewals."

Since lead as an alloying element in steel for machining purposes and in galvanised steel is understood to be relevant to all categories, it can be concluded that expiration dates should be specified for all categories.

18.5.6 The Scope of the Exemption

The scope of the current exemption is viewed as very wide. As mentioned above, the contribution of the Swedish Chemicals Agency KEMI makes reference to Article 5(1)(a) that stipulates an inclusion of materials and components of EEE for <u>specific</u> applications in the lists in Annexes III and IV. The specifications of applications are so far missing for exemption 6a. KEMI therefore proposes to split into a number of more specific exemptions, related to applications where it has been verified that feasible alternatives are currently not available without specifying whether these are applications of lead in steel for machining purposes or of galvanizing processes. As the present exemption 6a covers these different uses of lead with different purposes and different entry pathways, possibilities to narrow down the scope differ and will be discussed separately for steel for machining purposes and galvanized steel below.

Steel for machining purposes

The scope of the current exemption is viewed as very wide. However, EUROFER and EGGA only provide a list of typical components and not an exhaustive list. Thus the consultants cannot conclude on specific applications to narrow the scope of the exemption.

The consultants understand that there are alternatives on the market for at least some applications. However, it is not clear in what cases, or on what basis they cannot be used as substitutes for other applications, where, from the information provided by EUROFER and EGGA, leaded steel cannot be substituted. To clarify if they are not used at all or just not for the full range of applications, further information is needed. It can however be followed that the steel producer association is not able to provide such information.

The consultants would expect that the scope could be narrowed based on application groups or based on critical properties and required performance in application groups. This could require a supply chain survey, in order to collect and compile relevant information and to allow conclusions as to relevant properties and performance levels. Time may be needed in order to initiate such a survey along the supply chain to gain this information and screen all relevant applications relevant to arrive at an exhaustive list (of applications or of properties). However, this effort is presumed to be feasible as well as important for communicating to the steel customers where additional effort is needed in the applications of substitutes in the future.

EUROFER⁵⁹⁵ claims that "conventional machinability testing (for example ISO standard for tool life testing) can only be made for a selected system. This explains why each research institute or machining company has its own trials for machinability assessment. And if one parameter is changed (in our case lead or no lead) it may be possible that the whole system consequently has to be adjusted. And this explains why such studies can be made for some special applications but not yet for the whole machining industry."

Therefore it might be that an exhaustive list of properties also specifying the required performance level and the relevant performance indicators that are relevant for such properties might not be practicable to refine the scope of the exemption. To support this understanding, however, the complexity of the situation at hand needs to be presented and substantiated. The wide scope currently addressed in the exemption is open to misuse in cases where substitution might be possible. Therefore the consultants conclude that although a comprehensive list of applications may be long for refining the scope of the exemption, this is however of importance for establishing the potential of a change in scope. The consultants consider this to be the first step to further narrow the scope of the exemption, which the industry must be induced to undertake.

Galvanized steel

EGGA⁵⁹⁶ argues that the proposed addition in the wording formulation provides a narrowed scope for galvanized steel as the batch hot dip galvanized steel makes up less than 1% of the total galvanized steel.⁵⁹⁷ It is however understood that this reduction in scope to batch hot dip galvanized steel has been introduced to the ELV in 2010. Therefore the consultants estimate that this narrowing under RoHS rather describes the current practice.

A split of this part of the exemption for batch galvanized steel into an exemption that covers the unintentional presence of lead and applications where the addition of lead is needed does not seem to be practical against the background that the production of EEE components cannot be separated from the production of components for other product groups. EGGA⁵⁹⁸ argues that "no galvanizing plant is dedicated to EEE and EEE will normally represent a very small proportion of a plant's throughput. To generate an exhaustive 'positive list' of such products would be complex and difficult given EGGA's position in the supply chain; a galvanizing plant may operate with a lead level requiring

⁵⁹⁵ Op. cit. EUROFER (2016a)

⁵⁹⁶ Op. cit. EGGA (2016)

⁵⁹⁷ "Oeko report 07.0307/2008/517348/SER/G4 (21 June 2010) [Op. cit. Zangl et al. (2010)] on the adaptation to technical progress of ELV and ROHS directives estimated that 99% of the galvanized steel used in ELV applications was of the continuously galvanized type and that <1% was of the batch galvanized type. We estimate that a similar positon exists for EEE applications, which illustrates the significant narrowing of the exemption as a result of the efforts of zinc suppliers and steel industry and places a suitable to context to the current exemption request regarding batch galvanized steel."

exemption due to requirements of a product or processing characteristic that relates to 'non EEE' products/customers."

Generally, EGGA stated that there is much pressure from the customer's side to remove lead so that the intentional addition would phase out with time, irrespective of the fact that other product groups besides EEE and automotive components do not have the same lead restrictions.

18.5.7 Exemption Wording Formulation

The present Exemption 6a covers completely different uses of lead in steel with different purposes that could also be specified with different thresholds. A split of the exemption in the opinion of the consultants is possible.

The first part of the exemption should cover the use of lead as an alloying element in steel. For this part, the consultants agree with KEMI that there is a need to narrow the scope of the exemption. However, the consultants cannot conclude a list of exhaustive applications of lead in steel on the basis of the available information. The consultants agree that such an exhaustive inventory is needed in the future in order to further specify possibilities to narrow down the exemption to specific applications. Further steps that the consultants deem necessary for a future review are explored in Section 18.5.8.

Concerning batch hot dip galvanized steel, EGGA⁵⁹⁹ agreed to lower the threshold down to 0.2% provided that the wording formulation makes it clear that this threshold is calculated for the entire steel item.⁶⁰⁰ This reduced threshold of 0.2% has been proposed based on consultations across the industry according to EGGA.⁶⁰¹

EUROFER and EGGA explain that "*Pb levels range from <0.03% up to 0.8% Pb in the coating if this is considered the 'homogeneous material'. Steel items that have been batch hot dip galvanized would therefore readily comply with the upper exemption limit of 0.35% Pb previously established for machining steels*".⁶⁰² It is thus concluded that specifying a threshold for the presence of lead would depend on whether this threshold would relate only to the coating or to the complete steel part.

The current wording of ELV Annex II Exemption 1(a) is *"Steel for machining purposes and batch hot dip galvanised steel components containing up to 0,35 % lead by weight"*. Thus, should it be decided to renew the exemption in relation to the amount of lead in

⁵⁹⁹ EGGA (2015), European General Galvanizers Association (EGGA) (2015), Answers to 2nd Clarification Questions, submitted 14.12.2015.

⁶⁰⁰ EUROFER and EGGA (2015a) also state in this regard:

[&]quot;Lead has a low solubility in the zinc-iron alloys that are formed during the galvanizing reaction. Hence, the quantity of lead present in the coating is normally significantly lower than the lead present in the process bath – typically half as much. For a given bath composition, the variations of lead concentrations in the coating mainly depend on the steel type (reactivity with molten zinc)."

⁶⁰¹ Op. cit. EGGA (2016)

⁶⁰² Op. cit. EUROFER and EGGA (2015a)

the entirety of the galvanised part, reference to *"batch hot dip galvanised steel components"* should be made. In this case the threshold could be lowered to 0.2%.

Otherwise, the formulation should refer to the presence of lead in the coating of components, whereas the threshold may need to be adjusted to accommodate the higher levels of lead (i.e., up to 0.8%). EUROFER and EGGA⁶⁰³ explain that the batch hot dip galvanizing process allows the complete coverage of manufactured steel components with a metallurgically-bonded metallic coating that is formed through diffusion of iron and zinc, giving no clear delineation between coating and steel substrate. It is thus not clear if reference to the coating would be feasible in terms of market surveillance.

As further decrease in the lead content would only be expected in the long term due to the unintentional presence of lead in zinc scrap or irrespective of the requirement under RoHS, the consultants propose the exemption to be granted for the longest review period which is possible under RoHS.

18.5.8 Conclusions

Article 5(1)(a) provides that an exemption can be justified if at least one of the following criteria is fulfilled:

- their elimination or substitution via design changes or materials and components which do not require any of the materials or substances listed in Annex II is scientifically or technically impracticable;
- the reliability of substitutes is not ensured;
- the total negative **environmental**, **health and consumer safety impacts** caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof.

Overall, it seems important to differentiate in the future between the different uses in steel where lead provides necessary properties in steel alloy and is intentionally added and between galvanizing processes where lead is mostly unintentionally present.

As for lead in steel for machining purposes

- Substitution with bismuth containing steel might not be reliable and might cause negative environmental impacts. For the latter, not enough data is available to comprehensively conclude on this.
- Substitution via steel that does not contain lead is scientifically or technically
 practicable at least for some applications as shown by examples of
 PennEngineering with lead-free rephosphorised and resulfurised steel used
 for the production of specialty fasteners and of NSSMC with resulfurised
 steel used for the production of printer rails and printer shafts.

⁶⁰³ Op. cit. EUROFER and EGGA (2015a)

- The remaining applications have to be specified by performing and integrated survey of the supply chain in order to narrow the scope of the exemption to a comprehensive list of applications. This would need the engagement of EEE component manufacturers. As EUROFER and EGGA clarify the complexity of the supply chain, the consultants can follow that this would be time consuming. However, the consultants think that the current scope is not justified and recommend a short termed exemption to allow performing such a survey.
- The set-up of a comprehensive list of applications would also allow deciding, whether the lead content can be further reduced. Though the steel producers⁶⁰⁴ object to this approach due to decreased tool life and higher cutting forces, these machinability conditions seem to be adaptable in specific cases as the example of CETEHOR shows.

As for lead in galvanized steel, the consultants understand that lead does not provide a function in the coating of parts used in EEE. It is understood that there are two cases for the presence of lead. In some plants, lead is present at the bottom of galvanisation baths as it precipitates from secondary zinc added to the process, and may thus be present in galvanised products. In other cases, lead may be added to facilitate the galvanising process of certain parts (for example steel mesh used for construction). Such practices were explained not to be directly relevant to EEE parts. However, as the galvanisation of parts for EEE is performed in the same baths, the presence of lead in some cases cannot be excluded. In both cases, lead is understood not to serve a functional purpose in the galvanisation of steel parts for EEE, but to be a result of the use of secondary zinc or of the manufacture of other parts: "Lead is present in the zinc coating of galvanised steels. Lead has no beneficial (or adverse) effect on the coated product, but may have a technical influence on the galvanizing process in a small number of plants".⁶⁰⁵ The consultants conclude that the lead is mostly not intentionally added (or not added for itentions of relevance to the EEE part properties), but a result of the use of zinc scrap or of galvanizers' ashes. The intentional addition of lead to a galvanizing bath where it is technically required could not be separated for EEE specific processes or products, which are understood to have only a small share of all galvanised parts.

18.6 Recommendation

Based on the above considerations, it is recommended to split the exemption and provide different review periods for each entry.

A short review period of three years is proposed for applications where lead is present for machining purposes. The overall picture where substitution efforts are promising is not clear enough at present to allow an adjustment of the scope. In parallel it is

⁶⁰⁴ Op. cit. EUROFER and EGGA (2015b)

 $^{^{605}}$ Op. cit. EUROFER and EGGA (2015a)

established that substitutes are practical at least for some applications. The aim of a future review should therefore be to evaluate results of a comprehensive survey of the supply related to the applications of leaded steel alloys together with their technical requirements. The aim should be to check the applicability of a more narrow scope for the exemption. The consultants would further recommend cancelling the exemption, should industry fail to provide detailed and substantiated information in the future.

As for the exemption for batch hot dip galvanized steel, a lower threshold is proposed in agreement with the applicant for lead in batch hot dip galvanized steel items and a review period of the maximum permissible validity of five years is proposed for this part of the exemption, as the lead is mostly an unintentional impurity in the galvanizing bath.

Exemption 6a	Duration*
I) Lead as an alloying element in steel for machining purposes containing up to 0,35 % lead by weight	For Cat. 1-7 and 10 and 11: 21 July 2019
II) Lead in batch hot dip galvanized steel components containing up to 0.2% lead by weight	For Cat. 1-7 and 10 and 11: 21 July 2021
III) Lead as an alloying element in steel for machining purposes and in galvanized steel containing up to 0,35 % lead by weight	For Cat. 8 and 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat. 9 industrial: 21 July 2024;

Note: As it can be understood that the exemption duration may vary for various categories on the basis of Article 5(2), expiration dates have been specified here for all categories either on the basis of the requested duration in the exemption request which the consultants perceive to be justified, or on the basis of the validity periods specified in Article 5(2) for categories, which are newly in scope.

18.7 References Exemption 6a

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19.0 Exemption 6b: "Lead as an alloying element in aluminium containing up to 0,4 % lead by weight"

Declaration

In the sections that precede the "Critical Review" the phrasings and wordings of stakeholders' explanations and arguments have been adopted from the documents provided by the stakeholders as far as required and reasonable in the context of the evaluation at hand. Formulations have been altered in cases where it was necessary to maintain the readability and comprehensibility of the text. These sections are based exclusively on information provided by applicants and stakeholders, unless otherwise stated.

Acronyms and Definitions

2011	AA 2011, leaded Al wrought alloy			
AI	Aluminium			
AA 6023	Lead-free bismuth containing wrought alloy			
AIEco62Sn	Lead-free bismuth containing wrought alloy			
EAA	European Aluminium Association			
ECHA	European Chemicals Agency			
EEE	Electrical and Electronic Equipment			
ELV	End-of-Life Vehicle			
EoL	End-of-Life			
JBCE	Japan Business Council in Europe			
KEMI	Kemikalieinspektionen, Swedish Chemicals Agency			
Pb	Lead			
tpa	Tonnes per annum			
TMC	Test & Measurement Coalition			
WEEE	Waste of Electrical and Electronic Equipment			

19.1 Background

The European Aluminium Association (EAA), Sensata Technologies and Dunkermotoren have applied for the renewal of exemption 6b, requesting the current wording formulation of the exemption as appears in Annex III of the RoHS Directive.

Aluminium (AI) alloys can be differentiated into two principal classifications:⁶⁰⁶

- Wrought alloys: Al alloys primarily used for wrought products; they have an alloy content up to 10% and therefore strict and very low tolerance limits for the alloying elements. Wrought alloys are designated with a four-digit number according to the alloy designation system.
- **Cast alloys:** Al alloys primarily used for the production of castings; cast alloys have much higher tolerance limits for alloying elements; the alloy concentration is of up to 20%. For cast alloys, a different designation system with five digits is used.

The association of the AI manufacturers, EAA,⁶⁰⁷ with support of many EEE manufacturer associations⁶⁰⁸ requests the extension of the exemption without specifying an expiration date. Dunkermotoren,⁶⁰⁹ a component manufacturer, requests the exemption specifically for the manufacturing of gear parts in engine and transmission parts for a period of two to five years. Sensata Technologies, a manufacturer of sensor and control

⁶⁰⁶ EAA (202), European Aluminium Association EAA (2002), The Automotive Manual;

http://www.european-aluminium.eu/wp-content/uploads/2012/01/AAM-Materials-3-Designationsystem.pdf;

Paraskevas, D. et al. (2013), Closed and Open Loop Recycling of Aluminium: A Life Cycle Assessment perspective; 11th Global Conference on Sustainable Manufacturing, 23rd to 25th September Berlin, Germany.

⁶⁰⁷ EAA (2015a), European Aluminium Association (EAA) (2015a), Original Application for Exemption Renewal Request, submitted 16.01.2015, available under:

⁶⁰⁸ The EEA's exemption request was supported by the following bodies: American Chamber of Commerce to the EU (AmCham EU); Avago Technologies Limited; DIGITALEUROPE; European Committee of Domestic Equipment Manufacturers (CECED); European Copper Institute (ECI); European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry (COCIR); European Garden Machinery Industry Federation (EGMF); European Passive Components Industry Association (EPCIA); European Semiconductor Industry Association (ESIA); Gesamtverband der Aluminiumindustrie e.V.; Information Technology Industry Council (ITI); IPC - Association Connecting Electronics Industries; Knowles (UK) Ltd; LightingEurope; SPECTARIS; TechAmerica Europe; WirtschaftsVereinigung Metalle (WVM); ZVEI - Zentralverband Elektrotechnik- und Elektronikindustrie e.V..

⁶⁰⁹ Dunkermotoren GmbH (2015), Original Application for Exemption Renewal Request, submitted 15.12.2015, English version available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_b_/Dunkermotoren /Ex_6b_Dunkermotoren_150806_Ausnahmeantrag_Aluminium_englisch.pdf

products, stated after an investigation within its supply chain that the company is not making use of this exemption.⁶¹⁰

EAA thus requests the renewal of Ex. 6b with the following wording:

"Lead as an alloying element in aluminium containing up to 0,4 % lead by weight"

19.1.1 History of the Exemption

As for the history of the exemption, it has to be noted that since the RoHS 1 Directive was published in 2002, Exemption 6 has covered lead as an alloying element in steels, aluminium and copper.⁶¹¹ After the last revision on 2009⁶¹², exemption 6 was split into three exemptions 6a, 6b and 6c for each alloy respectively.

A corresponding exemption exists under the ELV Directive 2000/53/EC (ELV, listed in Annex II, as Exemption 2(c)). It was reviewed in 2015; the evaluation report has yet to be published. During the ELV revision, the consultants investigated the possibility of introducing a split into the aluminium alloy exemptions making a distinction between cases where AI is not intentionally introduced and cases where a lead content of up to 0,4 % by weight is required in AI alloys to enhance machinability. This split was proposed due to the information of the automotive industry that showed a clear distinction could be made into cast alloys that are used for big parts in vehicles, e.g. engine-blocks or gearbox housings, and between wrought alloys that are mainly used for manufacturing small parts, e.g. valve actuation, axis pins for pivot levers or oil return stop valves. The use of cast alloys in the automotive sector makes up 95% of the total use of leaded AI alloys in this sector.

⁶¹⁰ Sensata Technologies (2015b), Sensata Technologies Holland B.V. (2015b), Answers to Clarification Questions, submitted 20.08.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Sensata/Ex_6a6 b6c_Sensata_Questions_response_20150820.pdf

⁶¹¹ The wording of exemption 6 was as follows: "Lead as an alloying element in steel containing up to 0,35% lead by weight, aluminium containing up to 0,4% lead by weight and as a copper alloy containing up to 4% lead by weight"; <u>http://eur-lex.europa.eu/legal-</u>content/EN/TXT/PDE/?uri=CELEX:32002L0095&from=EN

content/EN/TXT/PDF/?uri=CELEX:32002L0095&from=EN ⁶¹² Gensch, et al. (2009), Carl-Otto Gensch, Oeko-Institut e. V., et al. 20 February (2009), Adaptation to scientific and technical progress under Directive 2002/95/EC: Final Report. With the assistance of Stéphanie Zangl, Rita Groß, Anna Weber, Oeko-Institut e. V. and Otmar Deubzer, Fraunhofer IZM. http://ec.europa.eu/environment/waste/weee/pdf/final_reportl_rohs1_en.pdf

Amount of Lead Used under the Exemption 19.1.2

According to EAA,⁶¹³ data availability is limited as to the amount of lead used under this exemption, due to a lack of knowledge on the type of leaded AI alloys used in EEE products and components on the EU market. EAA⁶¹⁴ explains that there are data on the " amount of wrought products, extruded products and secondary alloys shipped to the EEE and machinery sectors (consumption) from EU producers. However, there is no data available concerning which of these products/alloys contain lead and their quantity. Furthermore, no data available indicates that the amount of final EEE products produced using EU AI alloys is actually placed on the EU market."

When asked to indicate at least a range of the amount of leaded aluminium alloys in the EU used for EEE, EEA⁶¹⁵ states that "the potentially lead-containing AI alloys produced by producers in the EU and EFTA region (not the ones placed on the EU market) used in the high tech engineering sectors (not necessarily only EEE products) is most likely in the range of 100Kt to 1 Mt pa."

In this respect it can be noted that the U.S. Geological Survey Minerals Yearbook of 2014⁶¹⁶ estimates that 6.9% of AI product shipments of US and Canada are shipped to electronic end-users. In 2014 this share represented 809 thousand metric tonnes.

Description of Requested Exemption 19.2

According to information provided by EEA⁶¹⁷ in the original renewal request, the use of leaded AI alloys can be differentiated into AI alloys where the lead content is unintentional, due to the use of secondary raw material from aluminium scrap and into aluminium alloys, where lead is intentionally added for machining purposes:

Cast alloys unintentionally contain lead, due to the use of AI scrap for the manufacture of such alloys; relevant applications in which such alloys are used

The additional information was supported by the following industry associations and companies: DIGITALEUROPE; European Committee of Domestic Equipment Manufacturers (CECED); European Passive Components Industry Association (EPCIA); European Semiconductor Industry Association (ESIA); Gesamtverband der Aluminiumindustrie e.V.; Information Technology Industry Council (ITI); European Garden Machinery Industry Federation (EGMF); LightingEurope; ZVEI - Zentralverband Elektrotechnik- und Elektronikindustrie e.V.

http://minerals.usgs.gov/minerals/pubs/commodity/aluminum/myb1-2014-alumi.pdf ⁶¹⁷ Op. cit. EAA (2015a)

⁶¹³ EAA (2015b), European Aluminium Association (EAA) (2015b), Answers to Clarification Questions, revised version, submitted 14.08.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_b_/AISBL/2015081 4_Ex_6b_EAA_Ex_1st_round_of_Clarification-Questions_final_EAA_answer.pdf

⁶¹⁴ Op. cit. EAA (2015b)

⁶¹⁵ EEA (2016), European Aluminium Association (EAA) (2016), Answers to 2nd Clarification Questions, submitted 29.01.2016.

⁶¹⁶ USGS (2015), U.S. Geological Survey (USGS) (2015), Minerals Yearbook of 2014 – Aluminium [Advanced Release], table 6, pg. 5-15, available under:

include e.g. frameworks of lamps and lights, heat sinks, electrical and electronic items in housings etc.

Wrought alloys, or Al alloys intentionally containing lead for machining purposes: Relevant applications where such alloys are used are not detailed. The functions of lead are indicated as lubrication, better chip fracturing, surface finish, higher cutting speed and longer tool life. Wrought alloys are often used in screw machine products according to EAA⁶¹⁸, e.g. various machinery components, screws, bolts, fittings, nuts, automatic lathe products.

As this differentiation was in line with information available through the ELV review on leaded AI alloys used in the automotive sector, stakeholders were asked during the RoHS stakeholder consultation⁶¹⁹ whether a possible split of the exemption, differentiating between aluminium alloys where lead is not intentionally introduced and between aluminium alloys where lead is added to obtain certain properties would be practical. Thereupon, EAA⁶²⁰ submitted a contribution stating the following:

"As already stated, lead can be added to the alloys to perform a certain function and lead can be present in the alloys when alloys are produced e.g. from scrap. The former is termed as intentionally leaded alloys and the later, unintentionally leaded alloys. However, there is no straightforward link between intentional/unintentional and wrought/casting, i.e. while casting alloys are mostly produced from scrap, for the production of wrought alloys, scrap can also be used as input. Therefore a distinction of intentional and unintentional cannot be made according to the type of alloys.

The exemption 6b has been applied to Al alloys in general which has left the demand and market to determine the most effective utilisation of AI material available to EU producers. An arbitrary distinction of product by the purpose or none-purpose of lead could affect the supply and demand chain. The consequences of these changes are yet to be studied from technical, environmental and economical points of view. The industry will need time to comprehend such studies and changes."

⁶¹⁸ Op. cit. EAA (2015a)

⁶¹⁹ <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Consultation_Questionnaires/</u> Ex_6b_Consultation_Questionnaire.pdf ⁶²⁰ EAA (2015c), Contribution by European Aluminium Association (EAA) (2015c), submitted 19.10.2015,

available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_b_/Ex_6b_Europea n_Aluminium_Consultation_Questionnaire_answer_final_20151016.pdf

19.3 Applicant's Justification for Exemption

EAA⁶²¹ claims that the exemption of 0,4% lead content in aluminium provides the possibility of the use of recycled aluminium within the EU. EAA⁶²² explains that the scrap metal arising from products from the past can contain lead and that the presence of lead as impurity in the scrap flow is tolerated to a certain level for the production of many secondary alloys, which is specified in European standards.

EAA⁶²³ states that separation of lead from the scrap is feasible in the remelting stage by for example phase separation, electrochemical refining and vacuum distillation, but that these methods are only approved on a laboratory scale and from an environmental and economical perspective not practicable. According to EAA,⁶²⁴ the dilution of the scrap with primary aluminium results in higher environmental impacts due to the fact that the production of primary aluminium is very energy intensive.

As for lead in Al alloys used for machining purposes, EAA⁶²⁵ claims that lead acts as a lubricant during machining processes; through lead, better chip fracturing and surface finish as well as higher cutting speeds and a longer tool life are achieved. EAA was asked to exhaustively specify the functionality of lead in these applications e.g. specific function and properties, performance criteria, etc. EAA⁶²⁶ provided the following functionalities and performance aspects for lead in Al alloys:

- Corrosion resistance of manufactured articles;
- Surface finish of manufactured articles;
- Longer life of manufacturing tools and less energy consumption during machining of parts;
- Cutting speeds of manufacturing tools;
- · Lubrication effect in manufactured articles;
- · Better chip fracturing in manufactured articles;
- Temperature resistance;
- Electrochemical potential (of additive);
- Shrinking from liquid to solid phase (of additive);
- Durability of part;
- Eutectic point of alloy.

EAA did not provide performance indicators for these functionalities / performance aspects which would form a basis for testing the performance and comparing between AI alloys with and without lead. EAA⁶²⁷ stated thereupon that *"the industry will need*

- ⁶²⁴ Op. cit. EAA (2015a)
- ⁶²⁵ Op. cit. EAA (2015b)
- ⁶²⁶ Op. cit. EAA (2016)

⁶²¹ Op. cit. EAA (2015a)

⁶²² Op. cit. EAA (2015a)

⁶²³ Op. cit. EAA (2015a)

⁶²⁷ Op. cit. EAA (2016)

sufficient time to organise a team of experts to conduct a comprehensive study, if enough number of manufacturers would be willing to take part in the study. This study shall address the following:

- listing critical performance indicators for each of the functionalities of lead in Al alloys;
- measuring/testing these indicators for lead AI alloys;
- measuring/testing these indicators for potential substitutes if available.

Such study, including an initial information and data collection and analysis and later on carrying out the necessary experiments, usually takes more than one year."

EAA⁶²⁸ also claims that they cannot clearly distinguish between the use of cast and wrought alloys for specific components:

"The applications of Al Alloy (wrought and casting alloys) vary from one component to another. The use of the alloys is not strictly limited to a specific application in a component. Usually components producers design a component and specify the type of alloys they want to use to a supplier. There are hundreds if not thousands of components that may use Al alloys."

19.3.1 Possible Alternatives for Substituting RoHS Substances

EAA⁶²⁹ states that "substitution of lead as alloying element with bismuth is technically feasible." EAA⁶³⁰ further states that "lead-free alloys with bismuth as a substitute, such as AlEco62Sn or AA 6023, have been developed to replace as far as possible some applications of 2011 alloy in the automotive sector. However the current state-of-the-art does not indicate any suitable substitute for lead in aluminium alloys used in the production of EEE products."

As major constraints, EAA⁶³¹ claims that bismuth hampers existing recycling schemes and that secondary aluminium producers observe that bismuth creates an unwanted microstructure effect leading to potential problems in the refining and casting process. According to EAA,⁶³² bismuth alloys (if in large amount) need to be separated from the others prior to the remelting stage.

EAA⁶³³ further emphasises the possible restricted availability of bismuth as the production of bismuth is connected to the production of lead, in that the source of bismuth that comes to the market is a by-product of the lead production process.

⁶²⁸ Op. cit. EAA (2015b)

⁶²⁹ Op. cit. EAA (2015a)

⁶³⁰ Op. cit. EAA (2015a)

⁶³¹ Op. cit. EAA (2015a) and (2015b)

⁶³² Op. cit. EAA (2015a)

⁶³³ Op. cit. EAA (2015a) and (2015b)
19.3.2 Environmental Arguments

According to EAA,⁶³⁴ a closed loop system exists for AI that includes the AI scrap from EEE. EAA⁶³⁵ further states that AI recycling accounts for about 70% of the AI produced in the EU.

EAA⁶³⁶ claims that any restriction introduced to the exemption would impact the recycling of AI scrap and thus the EU circular economy.

19.3.3 Socio-Economic Impact of Substitution

As for the substitution of lead by bismuth, EAA⁶³⁷ expects an increase in direct production costs as bismuth is around 10 to 15 times more expensive than lead. Furthermore EAA states "*if the demand for bismuth increases and the demand for lead decreases, the price of bismuth may become even higher.*" EAA⁶³⁸ also claims an increase in fixed costs, but without giving further information.

19.3.4 Roadmap to Substitution

EAA⁶³⁹ did not provide a roadmap arguing that *"given the fact that there is no suitable alternative, it is impossible to draw up any detailed roadmap at this stage."*

19.4 Stakeholder Contributions

Five contributions to exemption 6b have been submitted during the stakeholder consultation. The contributions are presented in order of submission and shortly summarized:

- The **Robert Bosch GmbH**⁶⁴⁰ generally supports the applicants without providing further information.
- **JBCE**⁶⁴¹ Japan Business Council in Europe in a.i.b.l. states that they understand that EEE of category 8 and 9 are out of scope of this review. The JBCE understands that *"the exemption 6(b) in annex III can be applied to category 8&9*

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_b_/Comment_on_public_cousulation_of_Exemption_request_2015-2_6_b__.pdf

⁶³⁴ Op. cit. EAA (2015a)

⁶³⁵ Op. cit. EAA (2015a)

⁶³⁶ Op. cit. EAA (2015a)

⁶³⁷ Op. cit. EAA (2015a)

⁶³⁸ Op. cit. EAA (2015a)

⁶³⁹ Op. cit. EAA (2015b)

⁶⁴⁰ Robert Bosch GmbH (2015), Contribution by Robert Bosch GmbH, submitted 15.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_b_/Bosch-Stakeholder-contribution-Exemption-request-6b.pdf</u>

⁶⁴¹ JBCE (2015), Contribution by JBCE – Japan Business Council in Europe in a.i.b.l, submitted 15.10.2015, available under:

products for seven years from identified date when entry into force for each products, at the earliest July 2021."

EAA⁶⁴² adds "better heat treatment performance of the manufactured material" as one more function of lead.

EAA further comments on the proposal to split the exemption as detailed in section 19.3.

KEMI Kemikalieinspektionen, the Swedish Chemicals Agency⁶⁴³, interprets Article 5 in the RoHS Directive in the way that both the material or component and the specific applications need to be defined in the wording formulation of an exemption. Thus, "it is no longer legally possible to decide on an exemption for lead in aluminium alloys whatever the use is."

KEMI therefore proposes the split into a number of more specific exemptions related to applications where it has been verified that feasible alternatives are currently not available.

The Test & Measurement Coalition⁶⁴⁴ submitted a general contribution on Category 9 Industrial monitoring and control instruments, similar in nature to the contribution made by the JBCE.

19.5 Critical Review

19.5.1 **REACH Compliance - Relation to the REACH Regulation**

Appendix A.1.0 of this report lists Entry 63 in Annex XVII of the REACH Regulation, stipulating that lead and its compounds shall not be placed on the market or used in articles supplied to the general public, if the concentration of lead (expressed as metal) in those articles or accessible parts thereof is equal to or greater than 0,05 % by weight, and those articles or accessible parts thereof may, during normal or reasonably foreseeable conditions of use, be placed in the mouth by children.⁶⁴⁵ Entry 63 however further specifies this restriction not to be applicable for articles within the scope of the RoHS Directive 2011/65/EU.

Appendix A.1.0 of this report lists Entry 30 in Annex XVII of the REACH Regulation, stipulating that lead and its compounds shall not be placed on the market, or used, as

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_b_/Ex_6b_KEMI_A nswer to SC RoHS 20151016 Lead in aluminium.pdf 644 Test & Measurement Coalition (2015), Contribution by Test & Measurement Coalition, submitted 19

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_1_ae /General Contribution Test Measurement Coalition package 9 exemptions 20151016.pdf ⁶⁴⁵ Other restrictions of entry 63 cover e.g. jewellery and are thus not applicable here.

⁶⁴² EEA (2016), European Aluminium Association (EAA) (2016), Answers to 2nd Clarification Questions, submitted 29.01.2016.

⁶⁴³ KEMI (2015), Contribution by KEMI Kemikalieinspektionen, Swedish Chemicals Agency, submitted 19.10.2015, available under:

October 2015, available under

substances, constituents of other substances, or in mixtures for supply to the general public. A prerequisite to granting the requested exemption would therefore be to establish whether the intended use of lead in this exemption request might weaken the environmental and health protection afforded by the REACH regulation.

In the consultants' understanding, the restriction for substances under Entry 30 of Annex XVII does not apply to the use of lead in this application as lead is used as an alloying element. In the consultants' point of view it is not a supply of a lead as a substance, mixture or constituent of other mixtures to the general public. Pb is part of an article and as such, Entry 30 of Annex XVII of the REACH Regulation would not apply.

No other entries, relevant for the use of lead in the requested exemption could be identified in Annex XIV and Annex XVII (status January 2016).

Based on the current status of Annexes XIV and XVII of the REACH Regulation, the requested exemption would not weaken the environmental and health protection afforded by the REACH Regulation. An exemption could therefore be granted if other criteria of Art. 5(1)(a) apply.

19.5.2 Scientific and Technical Practicability of Substitution

Generally, the assessment of scientific and technical practicability of substitution of lead in Al alloys is hampered by the fact that EAA did not provide data on the use and application of Al alloys in the manufacturing of EEE.

Substitution of lead is relevant in the applications where lead is present to perform a specific function. It is understood from the information provided by EAA that this is the case for AI alloys where lead is needed for machining purposes. Substitution options with tin and bismuth containing AI alloys are discussed in the following Section 19.5.2.1. The arguments provided by EAA generally object to bismuth as an appropriate general substitute for lead and are discussed in Section 19.5.2.2.

The other applicant Dunkermotoren⁶⁴⁶ does not specify a substitute, but instead provides an estimate that to requalify each product with alternative materials of equivalent characteristics would require a period of 2 to 5 years.

19.5.2.1 Substitution of Lead in Al alloys

It has to be noted that EAA did not provide information of any new research or other activities that indicate efforts to substitute the applications of these leaded AI alloys. EAA states that there are lead-free bismuth containing AI alloys AIEco62Sn and 6023, but notes that they are used in automotive components. The automotive industry⁶⁴⁷ indicated that AIEco62Sn and 6023 are used to substitute some applications of the 2011 AI alloy e.g. in *"housings, disk plates, closing bodies, hexagonal nuts, sealing plugs,*

⁶⁴⁶ Op. cit. Dunkermotoren GmbH (2015)

⁶⁴⁷ Op. cit. ACEA et al. (2014)

anchors, washers. ^{*v*⁶⁴⁸} E.g. nuts are indicated by EAA to be manufactured by leaded AI alloys for EEE. Thus it can be assumed that the mentioned alloys are basically scientifically and technically practicable for substitution.

The AI manufacturer EURAL GNUTTI SpA.,⁶⁴⁹ identifying itself as of the largest European extruders of rods and bars in aluminium alloys with lead, contacted the consultants with the following statement:

"Since several years all major extrusion companies have studied alloys which can substitute lead, and the results were multiple, and very much satisfactory and already well accepted by the market.

We can assure and demonstrate that lead is absolutely unnecessary and can be eliminated, because there are now several alloys already well accepted in the automotive and electric/electronic industries, manufactured by several different extrusion companies, which can provide all the necessary characteristics by lead alloys which are: good machinability and chip forming, high mechanical properties, good surface finishing, good attitude to anodizing. There is no loss in any of the metal properties, no costs increase on the finished parts, on new aluminium lead-free alloys, which can justify the use of lead based alloys any further.

I understand that the majority of the industry (aluminium extruders and machining companies) is asking to maintain the actual exemption 6b to remain at Pb max 0,40% on weight, but this is due to an unwillingness to modify the majority of existing industrial drawings. Nevertheless in United States, in Japan, a huge step towards the elimination of lead has been taken since years now, and automotive companies are already choosing lead-free alloys on new drawings and new applications. All worldwide industry, but the European, is expecting the elimination of lead in aluminium alloys."

A patent and marked research on new Al alloy developments published in 2011 confirms that within wrought Al alloys, the AIMgSi alloys (6xxx series) and AlCu alloys (2xxx series) contain either lead with a maximum of 0.4% or as substitution elements tin or bismuth respectively a combination of both. EURAL⁶⁵⁰ stated that lead-free tin containing Al alloys have good machinability and good surface finishing, but suffer temperature limitations > 140°C because tin *"causes weakness and cracking of the machined parts when submitted to stress and high temperature. Due to its brittle nature, tin has the dangerous tendency to sudden brakes without significant previous deformation*

⁶⁴⁸ ACEA et al. (2015), ACEA, JAMA, KAMA, CLEPA and EAA (2015), Answers to Clarification Questionnaire during the review of ELV exemption 2c, provided 27 February 2015.

⁶⁴⁹ EURAL (2016a), EURAL GNUTTI SpA. (2016a), Information provided by Email, submitted 26 February 2016

⁶⁵⁰ EURAL (2016b), EURAL GNUTTI SpA. (2016b), Information provided by Email, submitted 29 February 2016

(strain). "651 However, EURAL⁶⁵² stresses that as many applications do not have stress and high temperature expositions tin based alloys are largely used on the market. For the tin and tin/bismuth based alloys, EURAL⁶⁵³ mentions different lead-free alloys of the following AI producers: Alcoa 6020, Eural 6012A, Constellium 6023, Impol 6028 and 2015, Aleris 6262A.

EURAL⁶⁵⁴ further states that the bismuth based alloys do not have such temperature limits. EURAL lists as lead-free bismuth containing alloys the above mentioned lead-free alloy AIEco62Sn of Aleris⁶⁵⁵ and lead-free developments by Kaiser (e.g. AA 6033)⁶⁵⁶ and the EURAL alloy 6026. According to EURAL it took "quite some time to set up such alloys [...], but now they are absolutely stable and giving excellent results, on each and every aspect related to machinability, chip forming, surface finishing, anodizing, corrosion resistance."

The EURAL 6026 alloy specification is presented in Annex A.4.0. The 6026 alloy is offered as being "particularly suitable for being machined on high speed automatic lathes. It has good resistance to corrosion, medium-high mechanical properties, good suitability for decorative and industrial hard anodizing. It is also used for hot forging purposes." EURAL provided a technical laboratory report on the manufacture of brake pistons from alloy 6026, which is provided in Annex A.4.0. EURAL⁶⁵⁷ concludes from their tests that there are "no important differences in any of the mechanical factors, nor in the roughness on surface of the anodized samples, nor in the macro-graphical nor micro-graphical analysis."

The performance aspects indicated for leaded AI alloys by EAA such as corrosion resistance, surface finish, temperature resistance and durability of manufactured articles are understood to be covered. Also the machinability aspects such as longer life of manufacturing tools and less energy consumption during machining of parts, cutting speeds of manufacturing tools, lubrication effect and better chip fracturing are understood to be comparable.

As for the application of 6026 in the EEE sector, EURAL⁶⁵⁸ explains to have "*customers*" who are switching to the Bi only in the field of electronic valves, safety components for gas kitchens and burners, pneumatic sector. Quantities are in the range of about 1000 metric tons/year global." EURAL⁶⁵⁹ estimates that a switch to lead-free AI alloys could be feasible for EEE manufacturers within one year taking into account replacement

⁶⁵¹ Cited from EURAL 6026 material data sheet provided in Annex A.4.0.

⁶⁵² Op. cit EURAL (2016b)

⁶⁵³ Op. cit EURAL (2016b)

⁶⁵⁴ Op. cit EURAL (2016b)

⁶⁵⁵ <u>https://www.aleris.com/wp-content/uploads/2014/08/Aluminum-Extrusion-Plant-</u> Overview_engl_DC_2012_11_20_final_web.pdf

 ⁶⁵⁶ <u>http://www.kaiseraluminum.com/customers/products/extrusions/bar/#6033</u>
 ⁶⁵⁷ EURAL (2016c), EURAL GNUTTI SpA. (2016c), Information provided by Email, submitted 01 March 2016.

⁶⁵⁸ Op. cit. EURAL (2016c)

⁶⁵⁹ Op. cit. EURAL (2016c)

strategy, process of renewing drawings and making all trials and tests, looking for suppliers and the phase out of old remaining stock of old materials.

The consultants understand from this information that there are alternatives on the market for lead based Al alloys that are reliable according to Al producers. It is also understood that in some cases EEE manufacturers already apply lead-free alloys, however the extent of these applications is not conclusive.

19.5.2.2 Arguments provided by EAA

EAA⁶⁶⁰ generally excludes bismuth as a substitute for lead in AI alloys for two reasons:

- Bismuth has no own primary production but is a by-product of lead production;
- Difficulties in AI recycling if the share of bismuth AI alloys rises.

A bismuth inventory set up for a life cycle assessment of solders for the US EPA in 2005⁶⁶¹ compiled data according to which bismuth is primarily co-mined with other metals, including lead (35%), copper (35%), tungsten (15-20%, from China), and tin and other miscellaneous metals (10 to 15%) concluding that lead and copper co-mining consist of the majority (70 percent) of the worldwide bismuth supply. The consultants assume that the co-mining of bismuth with lead is not a sufficient reason to claim that the substitution of bismuth causes higher negative environmental, health and consumer safety impacts compared to lead. It might show however that the availability of bismuth could be limited. Though bismuth is not considered as a critical raw material by the EC⁶⁶², there are individual studies⁶⁶³ that consider bismuth to be critical due to the production in a small number of countries and the production by co-mining. However, those considerations are not foreseen to be part of an exemption evaluation under RoHS. Furthermore, where bismuth would be produced through co-mining of lead, if the lead could not be used for manufacture, it would be concentrated at a single location (the smelting location). This would make the sound handling of lead and the control of possible emissions easier than the case of lead being present at a low concentration in numerous applications, for which proper disposal, collection and treatment are more complex.

As for the argument that bismuth hampers recycling, EAA did not provide any further evidence then the following: "*It has been experienced and discussed within the*

⁶⁶⁰ Op. cit. EAA (2015a)

⁶⁶¹ Geibig & Leet Socolof (2005), Geibig, J. R., Leet Socolof M. (2005), Solders in Electronics: A Life-Cycle Assessment, EPA 744-R-05-001, August 2005; available under:

http://www.epa.gov/sites/production/files/2013-12/documents/lead_free_solder_lca_full.pdf ⁶⁶² http://ec.europa.eu/growth/sectors/raw-materials/specific-interest/critical/index_en.htm

⁶⁶³ E.g. a study available in German on mineral resources: Erdmann, L.; Behrendt, S. Institut für Zukunftsstudien und Technologiebewertung (IZT), Berlin; Feil, M. adelphi, Berlin (2011), Kritische Rohstoffe für Deutschland "Identifikation aus Sicht deutscher Unternehmen wirtschaftlich bedeutsamer mineralischer Rohstoffe, deren Versorgungslage sich mittel- bis langfristig als kritisch erweisen könnte", Berlin, den 30. September 2011; available under: <u>https://www.izt.de/fileadmin/publikationen/54416.pdf</u>

secondary aluminium producers that bismuth creates an unwanted microstructure effect leading to potential problems in the refining and casting process. Thus bismuth alloys (if in large amount) need to be separated from the others for remelting."

On the basis of available documents concerning AI recycling,⁶⁶⁴ it is understood that in the recycling of aluminium the accumulation of impurities is a general problem for operators. E.g. the review of Gaustad et al. (2012)⁶⁶⁵ but also other publications⁶⁶⁶ mention two approaches commonly used today to deal with the presence of undesired impurities in the recycling of aluminium: Dilution and "Down-cycling" where wrought scrap is used in cast products because cast alloys have the lowest purity requirements. Compensation of impurities can take place by dilution with purer aluminium fractions or with primary aluminium in order to reach specified product quality. The following figure illustrates the AI recycling options that depend on the purity of the AI alloys.





Source: Paraskevas, D. et al. (2013)

⁶⁶⁴ Gaustad et al. (2012), Gaustad, G. et al. (2012), Improving aluminum recycling: A survey of sorting and impurity removal technologies; Resources, Conservation and Recycling 58 (2012) 79– 87; Op. cit. Paraskevas, D. et al. (2013);

EAA/OEA Recycling Division (2006), European Aluminium Association EAA and Organisation of European Aluminium Refiners and Remelters OEA (2006), Aluminium Recycling in Europe, The Road to High Quality Products, 2006; <u>http://www.european-aluminium.eu/wp-content/uploads/2011/08/Aluminium-recycling-in-Europe-2007.pdf</u>

⁶⁶⁵ Op. cit. Gaustad et al. (2012)

⁶⁶⁶ Paraskevas, D. et al. (2013)

Furthermore, EAA and OEA⁶⁶⁷ anticipate a growing volume of wrought alloy scrap as of 2015/2020, due to an increased use of specialized wrought alloys and therefore envisage optimised sorting techniques of different wrought alloys both from cars⁶⁶⁸ and from other sources in order to avoid dilution and down-cycling.

To conclude, the consultants cannot follow the arguments provided by EAA as to why bismuth poses a particular impurity problem in AI recycling. The consultants do not assume that if the exemption on leaded AI alloys for machining purposes will expire that AI recycling is endangered.

19.5.3 Environmental Arguments

As for cast alloys, the consultants understand that lead is unintentionally present due to the use of scrap and does not provide a function. In such cases, the consultants agree that the reuse of resources recycled from end-of-life (EoL) products has a positive value from an environmental perspective. According to EAA, the recycling of aluminium requires about 95% less energy than that required to produce primary aluminium.⁶⁶⁹ It is thus understood that the use of secondary material results in a significantly lower environmental impact in terms of energy consumption. Furthermore, it has been explained by EAA that the removal of lead from aluminium through a metallurgical process is technically not yet feasible on an industrial scale⁶⁷⁰ (see section 19.3). Thus the consultants can follow the estimation of EAA⁶⁷¹ that the elimination of lead from the AI recycling stream by methods such as phase separation, electrochemical refining and vacuum distillation is technically impracticable.

19.5.4 Stakeholder Contributions

Five contributions were submitted to the stakeholder consultation. The contributions of KEMI,⁶⁷² Bosch⁶⁷³ and EAA⁶⁷⁴ are discussed in the sections above as well as below.

The contributions submitted by TMC⁶⁷⁵ and JBCE⁶⁷⁶ raise a legal question as to the availability of the current exemption to category 8 and 9 equipment. TMC and JBCE claim the availability of Annex III exemptions to category 8 and 9 for seven years starting in 22.7.2017.

⁶⁶⁹ <u>http://european-aluminium.eu/data/recycling-data/</u>

⁶⁶⁷ Op. cit. EAA/OEA Recycling Division (2006)

⁶⁶⁸ Op. cit. EAA/OEA Recycling Division (2006)

⁶⁷⁰ Op. cit. EAA (2015a)

⁶⁷¹ Op. cit. EAA (2015a)

⁶⁷² Op. cit. KEMI (2015)

⁶⁷³ Op. cit. Bosch (2015)

⁶⁷⁴ Op. cit. EAA (2015c)

⁶⁷⁵ Op. cit. TMC (2015)

⁶⁷⁶ Op. cit. JBCE (2015)

EAA⁶⁷⁷ stated in this regard:

"We apply for renewal of this exemption for categories 1 to 7, 10 and 11 of Annex I for an additional validity period of 5 years. For these categories, the validity of this exemption may be required beyond this timeframe. Although applications in this exemption renewal request may be relevant to categories 8 & 9 this renewal request does not address these categories. Further, categories 8 & 9 have separate maximum validity periods and time limits for application for renewals...;"

As leaded Al alloys are understood to be relevant to all categories, it can be concluded that expiration dates should be specified for all categories.

19.5.5 The Scope of the Exemption

The scope of the current exemption is viewed as very wide. As mentioned above, the contribution of the Swedish Chemicals Agency KEMI makes reference to Article 5(1)(a) that stipulates an inclusion of materials and components of EEE for <u>specific</u> applications in the lists in Annexes III and IV. The specifications of applications are so far missing for exemption 6b. KEMI therefore proposes to split into a number of more specific exemptions, related to applications where it has been verified that feasible alternatives are currently not available.

EAA indicated some components manufactured by e.g. cast and wrought alloys but did not provide a comprehensive list because "*there are hundreds if not thousands components may use AI alloys*".⁶⁷⁸ It is possible that a comprehensive list of applications may be long and impractical for refining the scope of the exemption, though in lack of substitutes the consultants agree that clarifying this aspect would be of importance for understanding the potential for exemption specification. However, as discussed above there are substitutes for the use of leaded AI alloys for machining purposes. Therefore, it is assumed that such substitutes can be applied, whereas only for applications where performance can be proven as non-comparable could the exemption be renewed again should this be found to be justified in the next review of the exemption. If such applications would be made, it is expected that limiting the exemption to specific components or specific product ranges shall be addressed in applications. This would provide a basis for making such adjustments to future exemptions.

As for cast alloys, the consultants understand that lead is unintentionally present due to the use of scrap and does not provide a function. For the cast alloys produced from Al scrap, the substitution of lead is consequently not an issue. The consultants do not see the added value to specify applications for cast alloys but rather to specify the unintentional presence through an individual exemption. Therefore, the consultants favour the option of splitting the exemption, differentiating between aluminium alloys

⁶⁷⁷ Op. cit. EAA (2015a)

⁶⁷⁸ Op. cit. EAA (2015b)

where lead is not intentionally introduced and between aluminium alloys where lead is added to obtain certain properties. This is further discussed in the following Section 19.5.6.

19.5.6 Exemption Wording Formulation

The need to narrow down the exemption is evident. However, the consultants cannot conclude a list of exhaustive applications of leaded AI alloys for cast and wrought alloys on the basis of the available information, nor would it be practicable at present to conclude for each component whether lead-free substitutes are applied in some cases or not, i.e. if it is justified to retain the exemption for such components. Instead, a split of the exemption is considered between lead in AI alloys, provided that it is not intentionally introduced and in lead in AI alloys for machining purposes.

The first part covering the cast alloys could be granted for the longest review period, which is possible under RoHS, as to completely eliminate lead in recycled Al would only be possible in the long term. The quicker the shift to lead-free alloys, the quicker such a reduction could be expected, though it must be kept in mind that alloys used for EEE probably consist of less than 10% of the Al alloy market share. The second part of the split would allow setting a short review period for leaded Al used for machining purposes, in order to signalize the short termed validity of the exemption, so that industry can prepare for its expiration.

EAA argues that a differentiation into alloys where lead is unintentionally added is not straightforward because for the production of wrought alloys, scrap can also be used as input. However, in the consultants' opinion the term "not intentionally introduced" is meant to describe the presence of lead where its presence does not provide a function. Where lead is needed for providing a function, regardless if it is added to the alloy or if its presence as an impurity in recycled content is sufficient to ensure the relevant functions, its presence has an intention, i.e. to provide a specific function for the machining and/or in the final component.

The consultants understand from the input of EAA that for wrought alloys, the lead might not always be "newly" added but rather present at a sufficient concentration in Al used for production. However, taking into account the strict chemical composition of wrought alloys, the consultants understand that if wrought alloy scrap is used as input it has to be strictly sorted scrap. According to Paraskevas et al.⁶⁷⁹, the production of wrought alloys is heavily dependent on primary Al consumption due to their strict and very low tolerance limits for alloying elements. Thus the consultants understand that even if scrap is used in the production of wrought alloys, the lead level needs to be controlled and not only tolerated as impurity upon a specified level, i.e. the minimum amount needed to provide the relevant performance would need to be monitored and where lacking corrected.

⁶⁷⁹ Op. cit. Paraskevas, D. et al. (2013)

Another aspect for cast alloys, relevant in the long term is that the content of lead in cast alloys produced from scrap is expected to decrease: The automotive industry and European Aluminium Association⁶⁸⁰ stated during the recent revision of the corresponding ELV exemption that "since last stakeholder consultation [on the corresponding ELV exemption in 2009/2010], a slight reduction of the average Lead amount introduced by recycling could have been recognized. This can be explained by larger shares of the cars/industrial goods that will be recycled has been produced under Lead restrictions." Questioned whether the same is true for WEEE recycling and whether all AI scrap is collected and treated together (or alternatively if applications from different sectors are collected and treated separately), EAA⁶⁸¹ states that "this decreasing trend observed in the recycling of ELVs is not yet visible in the case of EEEs. Compared to AI scrap from ELVs, the amount of AI scrap from EEE is much smaller. Also, most of the AI scraps from EEE waste, though maybe collected and treated separately, are recycled together with other AI scraps. This could be the main reason that the change of Pb content is not so visible in the case of WEEE." To conclude however, it can be expected the lead content will decrease, which could be reflected in future reviews by lowering the threshold for the unintentional presence of lead in Al alloys. The automotive industry⁶⁸² estimates the maximum lead content in recycled Aluminium from ELVs in 2023 at 0.2% in Western Europe and at 0.24% in South Eastern Europe. As it is understood that AI alloys from EEE are recycled with alloys of other sources, a similar reduction in the amount of lead in lead-based cast alloys can also be expected.

19.5.7 **Conclusions**

Article 5(1)(a) provides that an exemption can be justified if at least one of the following criteria is fulfilled:

- their elimination or substitution via design changes or materials and components which do not require any of the materials or substances listed in Annex II is scientifically or technically impracticable;
- the **reliability** of substitutes is not ensured; .
- the total negative environmental, health and consumer safety impacts caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof.

In the consultants' opinion, a split of the exemption would allow differentiating in the future between applications of aluminium alloys where lead is unintentionally present and between applications where lead provides necessary properties.

⁶⁸⁰ ACEA et al. (2014), ACEA, JAMA, KAMA, CLEPA and EAA (2014a), Industry contribution of ACEA, JAMA, KAMA, CLEPA and EAA, submitted during the online stakeholder consultation, retrieved from http://elv.exemptions.oeko.info/fileadmin/user_upload/Consultation_2014_1/Ex_2c/20141210_ACEA_An nexII_2c_amended.pdf ⁶⁸¹ Op. cit. EAA (2015b)

⁶⁸² Op. cit. ACEA et al. (2015)

As for the unintentional presence of lead, elimination from the AI recycling stream does not seem to be technically practicable because available methods are not developed beyond a laboratory scale. It is further understood that the use of secondary lead in the production of AI alloys for casting allows a significant reduction in the energy consumed to produce the alloys (i.e. the energy associated with the manufacture of primary AI is significantly reduced). Thus, lead as an impurity is to be accepted though it is understood that the level of impurities in alloys is controlled. Therefore the consultants recommend granting the maximum exemption validity possible under RoHS for various categories. In the long term however, it is expected that that the lead content in the AI recycling stream will decrease and this should be monitored in the future as it can be expected to be the focus of future reviews.

As for lead in Al alloys for machining purposes, it can be followed that substitutes are available on the market for which reliability is claimed by alloy producers. In the consultants opinion EU COM should give a clear sign to industry that this exemption is to expire, that the available substitutes are to be tested and implemented as such. Further exemptions for specific applications shall only be acceptable where there is sufficient evidence that lead cannot be reliably substituted. In this case, the consultants propose a review period of three years.

From available documentation, the consultants cannot conclude to what degree, the majority of EEE manufacturers are aware of these new developments and subsequently if broad range substitution can be assumed to be underway or not. Manufacturers of EEE products and components did not participate in the stakeholder consultation and EEA claims not to have access to such data.

The consultants conclude that the exemption could be renewed for a short period, to allow EEE manufacturers a sufficient transition period for applying lead-free alloys available on the market. From EURAL's information the implementation of substitutes does not require more than a year. Though this could allow a phase-out of lead-based alloys within a short period, EURAL submitted its information shortly before the evaluation concluded. Other stakeholders have not had a chance to become familiar with such information and its possible implications, and shall not have one before the publication of this report, and it is thus anticipated that a longer period could be relevant. E.g. the applicant Dunkermotoren⁶⁸³ estimates to need a period of 2 to 5 years for requalification of each product (gear parts in engine and transmission parts). Furthermore, as the amount of components to be covered could be significant, a longer transition period would be needed, also allowing manufacturers to apply for new exemptions for the use of specific lead-based alloys in specific components, where third party testing can substantiate that lead-free alloys provide inferior performance.

⁶⁸³ Op. cit. Dunkermotoren GmbH (2015)

19.6 Recommendation

Based on the above considerations, it is recommended to split the exemption. A review period of five years is proposed for the exemption entry on the unintentionally introduced lead, i.e., alloys used for the production of non-machined parts.

A short review period of three years is proposed for applications where lead is present for machining purposes. This would allow industry a longer transition period towards substitutes, as well as providing time to apply for new exemptions should substitutes not be comparable in performance for specific applications.

Exemption 6b: Lead as an alloying element in aluminium	Duration*
<i>I) with a lead content up to 0.4 % by weight, used for the production of parts not machined with shape cutting chipping technologies</i>	For Cat. 1-7 and 10 and 11: 21 July 2021
II) for machining purposes with a lead content up to 0.4 % by weight	For Cat. 1-11: 21 July 2019
III) Lead as an alloying element in aluminium containing up to0,4 % lead by weight	For Cat. 8 and 9: 21 July 2021 For Sub-Cat. 8 in-vitro: 21 July 2023 For Sub-Cat. 9 industrial: 21 July 2024

Note: As it can be understood that the exemption duration may vary for various categories on the basis of Article 5(2), expiration dates have been specified here for all categories either on the basis of the requested duration in the exemption request which the consultants perceive to be justified, or on the basis of the validity periods specified in Article 5(2) for categories, which are newly in scope.

19.7 References Exemption 6b

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- ACEA et al. (2015) ACEA, JAMA, KAMA, CLEPA and EAA (2015), Answers to Clarification Questionnaire during the review of ELV exemption 2c, provided 27 February 2015.
- Dunkermotoren GmbH (2015) Dunkermotoren GmbH (2015), Original Application for Exemption Renewal Request, submitted 15.12.2015, English version available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6 _b_/Dunkermotoren/Ex_6b_Dunkermotoren_150806_Ausnahmeantrag_Aluminium_ englisch.pdf

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http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6 _b_/Bosch-Stakeholder-contribution-Exemption-request-6b.pdf

Sensata Technologies (2015a) Sensata Technologies Holland B.V., Original Application for Exemption Renewal Request, submitted 15.01.2015, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6 _b_/Sensata/6a_6b_6c_RoHS-Exemptions_Application-Format_Ex_6a_b_c_Pb_in_St_Al_Cu.pdf

Sensata Technologies (2015b) Sensata Technologies Holland B.V., Answers to Clarification Questions, submitted 20.08.2015, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6 _c_/Sensata/Ex_6a6b6c_Sensata_Questions_response_20150820.pdf

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20.0 Exemption 6c: "Copper alloy containing up to 4% lead by weight"

Declaration

In the sections that precede the "Critical Review" the phrasings and wordings of stakeholders' explanations and arguments have been adopted from the documents provided by the stakeholders as far as required and reasonable in the context of the evaluation at hand. Formulations have been altered in cases where it was necessary to maintain the readability and comprehensibility of the text. These sections are based exclusively on information provided by applicants and stakeholders, unless otherwise stated.

Acronyms and Definitions

353 / C35300	Copper alloy with 1.5 to 2.5% Pb
360 / C36000	CuZn39Pb3, copper alloy with 3.3% Pb
CuZn21Si3P	Lead-free silicon-containing copper alloy
CuZn39Pb3	Copper alloy with 3.3% Pb
CuZn37Mn3Al2PbSi	Copper alloy with 0.2 to 0.8% Pb
CuZn42	Lead-free copper alloy with a higher zinc content
ECHA	European Chemicals Agency
EEE	Electrical and Electronic Equipment
ELV	End-of-Life Vehicle
HID	High intensity discharge lamps
JBCE	Japan Business Council in Europe
KEMI	Kemikalieinspektionen, Swedish Chemicals Agency
LEU	LightingEurope
Pb	Lead
ТМС	Test & Measurement Coalition
Тра	Tonnes per annuum
WEEE	Waste EEE

20.1 Background

Lead is embedded as tiny nodules in the matrix of copper alloys. It thereby acts as chip breaker and lubricant. This gives leaded copper alloys a favourable machinability, but also properties provided by lead in the finished component, such as e.g. electrical conductivity, slide functionality for parts with closely fit sliding surfaces and corrosion resistance.

The lead content in copper alloys (brass) can vary between 0.2 to 4.2% in accordance with European standards.⁶⁸⁴ Among them, the alloy CuZn39Pb3 / C36000 is very commonly used as a standard alloy of copper and zinc containing 3.3% lead.

Six applications were made requesting a renewal of the exemption; they are presented here in alphabetical order of the applicants' names:

- Bourns Inc.,⁶⁸⁵ an electronic component manufacturer, purchases different components manufactured from leaded copper alloys such as bushings, terminals, shafts, pins, backup strips, terminal strips, switch elements/ terminals, rivets. Bourns Inc.⁶⁸⁶ explains that leaded copper alloys can be precisely processed in fast screw machines and provide corrosion resistance.
- Dunkermotoren GmbH⁶⁸⁷ request the exemption for gear wheels and motor bushes for different motor applications. The leaded copper alloys allow a long lifetime of the machining tools and of the finished gear box application due to the slide functionality of lead. According to Dunkermotoren,⁶⁸⁸ their applications could be manufactured with leaded copper alloys with a lead content of < 1%. Dunkermotoren⁶⁸⁹ added that the lower threshold is only applicable to electrical drive technology and that their "*execution cannot be transferred to other industries*".

688 Op. cit. Dunkermotoren (2014)

⁶⁸⁴ CEN EN 12164 and 12165

⁶⁸⁵ Bourns (2015a), Bourns, Inc. (2015a), Original Application for Exemption Renewal Request, submitted 19.01.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Bourns/6c_Exemption_extension_ap_6c.pdf

⁶⁸⁶ Bourns (2015b), Bourns, Inc. (2015b), Answers to Clarification Questions, submitted 29.08.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Bourns/201508 11_Bourns_Ex_6c_1st_round_of_Clarification-Questions.pdf

⁶⁸⁷ Dunkermotoren (2014), Dunkermotoren GmbH (2014), Original Application for Exemption Renewal Request, submitted 15.12.2014, English version available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Dunkermotoren_/151008_Anmerkungen_Ausnahmeantrag_Dunkermotoren_6c_Messing_english.pdf

⁶⁸⁹ Dunkermotoren (2015), Dunkermotoren GmbH (2015), Additional Information to the Application, submitted 08.10.2015, available under:

<u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Dunkermotoren</u> /Additional_information_to_our_application_6c___Dunkermotoren.pdf

- Framo Morat GmbH & Co. KG⁶⁹⁰ produces the *"soft partner of worm gears"* from leaded copper alloys for good machinability and because it supports the dry-running of the gear parts.⁶⁹¹ According to Framo Morat the copper alloy CuZn37Mn3Al2PbSi that has been tested within the company over a long time period for its mechanical properties. Especially the *"load-carrying capacity"*, is an essential manufacturing parameter, experience with which is based on *"decades of internal testing and recording"*. Framo Morat sells *"more than a million worm gears to more than 275 customers all around the world placed in all branches."* Therefore Framo Morat cannot specify all the applications where the worm gears are used in.
- LightingEurope (LEU)⁶⁹² requests the exemption for contact-pins of various fluorescent lamps and starters for fluorescent lamps, GU10 (a type of lamp fixture) reflector lamps and high intensity discharge (HID) R-mini lamps. LEU states that the presence of lead results in a higher ductility of the copper-alloy pins.
- **PHOENIX Contact GmbH&Co. KG and HARTING KGaA**,⁶⁹³ both component manufacturers of connectors, device connection technology and network components, switchgears, fieldbus components etc. requested the exemption on behalf of a number of organisations.⁶⁹⁴ They do not apply for their own

⁶⁹⁰ Framo Morat (2014), Framo Morat GmbH & Co. KG (2014), Original Application for Exemption Renewal Request, submitted 10.12.2014, English version available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Framo/Ex_6c_F ramo_Morat_2015-08-13_RoHS_Exemption_Request_fkn_Public.pdf

⁶⁹¹ Framo Morat (2015), Framo Morat GmbH & Co. KG (2015), Answers to Clarification Questions, submitted 18.08.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Framo/2015081 8_Ex_6c_FramoMorat_1st_round_of_Clarification-Questions_fkn.pdf

⁶⁹² LEU (2015a), LightingEurope (2015a), Original Application for Exemption Renewal Request, submitted 16.01.2015, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/ Exemption_6_c_/Lighting_Europe/6c_LE_RoHS_Exemption_Req_Final.pdf

 ⁶⁹³ Phoenix Contact and Harting (2015a), PHOENIX Contact GmbH&Co. KG and HARTING KGaA (2015a), Original Application for Exemption Renewal Request, submitted 16.01.2015, available under:
 <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Phoenix/6c_Ro</u>
 <u>HS_Exemption_6c_Renewal_Dossier_16_JAN_2015.pdf</u>
 ⁶⁹⁴ The following 26 organizations supported the request (in alphabetical order): American Chamber of

⁶⁹⁴ The following 26 organizations supported the request (in alphabetical order): American Chamber of Commerce to the EU (AmChamEU), Avago Technologies Limited, Communications and Information network Association of Japan (CIAJ), DIGITALEUROPE, European Committee of Domestic Equipment Manufacturers (CECED), European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry (COCIR), European Copper Institute (ECI), European Garden Machinery Industry Federation (EGMF), European Partnership for Energy and the Environment (EPEE), European Passive Components Industry Association (EPCIA), European Power Tool Association (EPTA), European Semiconductor Industry Association (ESIA), Information Technology Industry Council (ITI), IPC-Association Connecting Electronics Industries, Japan Business Council in Europe (JBCE), Japan Business Machine and Information System Industries Association (JBMIA), Japan Electrical Manufacturers' Association (JEMA), Japan Electronics and Information Technology Industries Association (JEITA), Knowles, LIGHTINGEUROPE, Littelfuse, Orgalime, the European Engineering Industries Association, SPECTARIS, TechAmerica Europe

specific applications but rather provide a generic review of the uses of leaded copper alloys. It is not always comprehensible whether e.g. publically funded research or research conducted by the automotive industry is cited or whether own research is presented by Phoenix Contact and Harting. Phoenix Contact and Harting indicate contact spring legs, crimp contacts, gear pinions and bearings and bushings as applications of leaded copper alloys.

Sensata Technologies⁶⁹⁵ purchases connectors, bushings, terminals, screws, hex nuts, washers, rivets for their following applications: thermal motor protectors, thermal circuit breakers, hydraulic magnetic circuit breakers.

Five out of six applicants⁶⁹⁶ request a renewal of the exemption with the current wording:

"Copper alloy containing up to 4% lead by weight"

A further application submitted did not fulfil the minimum requirements of applications for exemptions stipulated in Annex V of the Directive and was not evaluated as such.

As for the history of the exemption, it has to be noted that since the RoHS 1 Directive was published in 2002, Ex. 6 has covered lead as an alloying element in steels, aluminium and copper.⁶⁹⁷ Following the last revision on 2009⁶⁹⁸, Ex. 6 was split into three exemptions 6a, 6b and 6c for each alloy respectively.

There is a corresponding exemption in the end-of-life vehicles Directive 2000/53/EC (ELV, listed in Annex II, as Exemption 3) with the same wording "Copper alloy containing up to 4% lead by weight". It was reviewed in 2015 by Oeko-Institut; the evaluation report has yet to be published. Where relevant within this chapter, it is referred to as the ELV revision.

⁽TAE), WirtschaftsVereinigung Metalle (WVM), Zentralverband Elektrotechnik-und Elektronikindustrie e. V. (ZVEI).

⁶⁹⁵ Sensata (2015a), Sensata Technologies Holland B.V. (2015a), Original Application for Exemption Renewal Request, submitted 15.01.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_b_/Sensata/6a_6b _6c_RoHS-Exemptions_Application-Format_Ex_6a_b_c_Pb_in_St_Al_Cu.pdf

Sensata (2015b), Sensata Technologies Holland B.V. (2015b), Answers to Clarification Questions, submitted 20.08.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Sensata/Ex_6a6 b6c_Sensata_Questions_response_20150820.pdf

⁶⁹⁶ Dunkermotoren (2014) requested a lower threshold however stated later that this would be only applicable to their specific application (Dunkermotoren 2015)

The wording of exemption 6 was as follows: "Lead as an alloying element in steel containing up to 0,35% lead by weight, aluminium containing up to 0,4% lead by weight and as a copper alloy containing up to 4% lead by weight"; http://eur-lex.europa.eu/legal-

content/EN/TXT/PDF/?uri=CELEX:32002L0095&from=EN ⁶⁹⁸ Gensch et al. (2009), Carl-Otto Gensch, Oeko-Institut e. V., et al. 20 February 2009, Adaptation to scientific and technical progress under Directive 2002/95/EC: Final Report. With the assistance of Stéphanie Zangl, Rita Groß, Anna Weber, Oeko-Institut e. V. and Otmar Deubzer, Fraunhofer IZM. http://ec.europa.eu/environment/waste/weee/pdf/final_reportl_rohs1_en.pdf

20.1.1 Amount of Lead Used under the Exemption

Phoenix Contact and Harting⁶⁹⁹ state that it is "unfortunately not possible to identify exhaustively the components and EEE that use leaded copper alloys. As consequence the amount of lead per year cannot be calculated. An estimation based on the data of only two companies would not reflect the situation of the EEE industry." When asked to provide an estimation, Phoenix Contact and Harting stated the following:

"Ca. 2500 tpa lead based on a use amount of leaded alloys in EEE of 100,000 tpa with 2.5% lead threshold is assumed. Taken the recycling rate of more than 90% for these alloys 250 tpa new lead are needed for the market."

The other applicants (in alphabetical order) provided the following amounts:

- Dunkermotoren⁷⁰⁰ estimates that it places 1.7 t of lead per annum on the market.
- Framo Morat⁷⁰¹ estimates the amount of lead, which was placed on the market in 2014, at about 700kg.
- LightingEurope⁷⁰² calculates a total amount of approximately 38 ton of lead per year but stated that this amount will gradually decrease in the coming years because LED lamps have a longer life-time compared to conventional lamps.
- Sensata⁷⁰³ estimates the amount of lead in lead-containing copper alloys used in Sensata products placed on the EU market at 500kg.

Bourns⁷⁰⁴ provides a list that indicates the amount of Pb in its finished units. However, Bourns further states that it is not able to calculate the amount of lead because Bourns' parts are not finished parts. They are used in the assembly of other goods in the various EEE categories thus Bourns cannot determine the final use of their parts: "Once our parts are sold either directly or through distribution, we do not have information on how all parts are used."

In the last revision of this exemption the following estimate was made: "*The average annual consumption of leaded brass in the EU is approximately 1,500,000 t. Figures on the share in the electronic sector have not been provided by the copper industry. However, it is estimated that yearly quantities in ICT equipment are ten tonnes at*

⁶⁹⁹ Phoenix Contact and Harting (2015b), PHOENIX Contact GmbH&Co. KG and HARTING KGaA (2015b), Answers to Clarification Questions, submitted 14.09.2015, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Ex_6c_Phoenix

Harting_Answers_1st_round_clarifying_questions_14.09.2015.pdf

 ⁷⁰⁰ Op. cit. Dunkermotoren (2015a)
 ⁷⁰¹ Op. cit. Framo Morat (2015)

⁷⁰² Op. cit. LEU (2015a)

⁷⁰³ Op. cit. Sensata (2015b)

⁷⁰⁴ Op. cit. Bourns (2015b)

maximum." Taking into account the amounts of lead indicated by LEU, this can be understood to have been heavily underestimated.

20.2 Description of Requested Exemption

According to Phoenix Contact and Harting,⁷⁰⁵ it is not possible to exhaustively identify the components and EEE that use leaded copper alloys. Phoenix Contact and Harting⁷⁰⁶ explain that this is due to a complex structure of the supply chain where material specifications are not recorded and manufacturers of components/parts supply their products to different industries:

"In electrical and electronic industry there is no common database on the chemical composition of single parts. In addition the diversity of products is very high as RoHS covers diverse types of EEE and their components. These components are used in different industries with different requirements, organisations and structures. The consequence of this situation is that it is not possible to provide a list of components or equipment that contains leaded copper alloys."

From the applications of single companies, gears as mechanically moving components can be differentiated from other applications: For the manufacturing of the gear parts, the applicants Dunkermotoren and Framo Morat mention that a leaded copper alloy (CuZn37Mn3Al2PbSi) is used (Framo Morat) or can exclusively be used (Dunkermotoren) that contains a lead of < 1% by weight.

Other components mentioned by the applicants are a variety of small parts that partly have electrical/conductive functions, such as the contact-pins LEU specified in its renewal request. Bourns⁷⁰⁷ indicate the following applications containing the following components of leaded copper alloys: Brass pins, shafts, bushings, brass backup strips, terminals, terminal strip, switch element/terminal. Sensata⁷⁰⁸ indicate very similar components to be made from leaded copper alloys: bushings, terminals, screws, hex nuts, washers, rivets. Phoenix Contact and Harting⁷⁰⁹ mention some examples of components made from leaded copper alloys: spring contacts, crimp contacts and gears as an example of mechanical connecting parts.

As for the applications related to the different components, the applicants explain the following:

⁷⁰⁵ Op. cit. Phoenix Contact and Harting (2015b)

⁷⁰⁶ Op. cit. Phoenix Contact and Harting (2015b)

⁷⁰⁷ Op. cit. Bourns (2015a)

⁷⁰⁸ Op. cit. Sensata (2015b)

⁷⁰⁹ Op. cit. Phoenix Contact and Harting (2015a)

 Bourns⁷¹⁰ uses the above mentioned components in counting dials, encoders, panel controls, precision potentiometers, rotary sensors and trimming potentiometers.

Bourns further state: "With the wide use of applications for electronic components, subassemblies containing electronic components and finished products containing electronic components, it is not possible for Bourns to determine the final use in the various EEE categories. Some, such as EEE categories 1-9 are highly likely along with 11. Once our parts are sold either directly or through distribution, we do not have information on how all parts are used. Bourns' parts are not finished parts but used in the assembly of other goods such as cell phones and computers to name a few. Bourns cannot determine where the global parts that claim exemption 6c are used and the final destination of that finished product. Further, the end products that use these parts may not be under the RoHS scope. There may be other applications using this exemption that are out of the scope of Bourns customer base. There are just too many unknowns to provide accurate information."

- According to Dunkermotoren,⁷¹¹ the gear parts can be used in various EEE such as "slicers, retail scales, printers, woodworking machines, under water scooter, rehabilitation machines, dialysis machines, medial pumps, operating tables, magnetic resonance tomography, cash machines, automatic doors and automatic sun protection as well as in IT and telecommunication equipment, electrical and electronic toys, leisure and sports equipment, medical devices, automatic dispensers and other EEE not covered by any of the categories above."
- Framo Morat⁷¹² explains that "there are two possibilities to order a worm gear set. First there are catalogue sets which can be ordered right away and are in stock. The other opportunity is to order customized worm gears which are designed in a specific way for every customer himself. Considering the possibility of catalogue sets it is difficult to trace the final application, in which Framo worm gears can be found. One of the nameable examples is definitely the sector of geared motors and their affiliated surroundings."
- Lighting Europe⁷¹³ explains that the pins are used in various lamps and starters for lamps as already mentioned above.
- Sensata⁷¹⁴ describes that their sensor and control products are used in the following EEE: thermal motor protectors, thermal circuit breakers, hydraulic magnetic circuit breakers.

⁷¹⁰ Op. cit. Bourns (2015b)

⁷¹¹ Op. cit. Dunkermotoren (2014)

⁷¹² Op. cit. Framo Morat (2014)

⁷¹³ Op. cit. LEU (2015a)

⁷¹⁴ Op. cit. Sensata (2015b)

20.3 Applicant's Justification for Exemption

The justifications of the applicants for their specific components are summarized in the following Table 20-1. The applicants generally refer to a favourable machinability of leaded copper alloys, which is not substantiated further. In most cases the applicants also claim that the lead in the finished product has an additional function in the finished product. These functions are e.g. conductivity, corrosion resistance, dry-running performance or wear resistance.

Sensata⁷¹⁵ generally claims that "because leaded copper alloys are not cheap, nor light, these materials will only be selected in product designs when needed under harsh mechanical and environmental conditions from the application and manufacturing point of view. Mostly in small parts that require smooth surfaces and narrow tolerances alike sliding elements, mechanical contacting elements and electrical applications."

⁷¹⁵ Op. cit. Sensata (2015b)

Applicant	Part of Leaded Copper Alloy	Aspects of Machinability	Function of Lead in the Manufacturing of Product	Function of Lead in the Finished Product	Additional aspects
Framo Morat	Worm gear	Excellent mechanical properties	n.s.	Dry-running performance -> Increases of product lifetime and safety	Calculation of load-carrying capacity of leaded copper alloy are based on decades of internal testing and recording,* Economical characteristics
Dunker- motoren	Gear parts, Motor parts, typically bushes	Higher lifetime of tools, Lower process time.	n.s.	Reduction of sliding properties of gear parts in the gear box	n.s.
Bourns	Brass pins, shafts, bushings, Brass backup strips, Terminals, terminal strip, Switch element	Lubrication and chip control in order to run on automatic screw machines, Lead reduces heat generation during screw machine process, Less wear on tooling	n.s.	Brass forms a tin protective patina, Mechanical strength	Competitive cost, Availability of material in small bar sizes to reduce waste
LEU	Contact-pins in different forms	Reference made to Phoenix Contact and Harting	Ductility to provide a reliable connection of lead wire from the lamp to the contact-pin -> safety issue	Conductivity, Corrosion resistance, Ductility -> Integrity over lifetime Elasticity, Tensile strength	Ongoing changes in the lighting industry -> reluctance of suppliers to investments
Sensata	Connectors, bushings, terminals, screws, hex nuts, washers, rivets	n.s.	n.s.	n.s.	Restricted use of leaded copper alloy because material not cheap and not light

Table 20-1: Summary of the justification for exemption

Applicant	Part of Leaded Copper Alloy	Aspects of Machinability	Function of Lead in the Manufacturing of Product	Function of Lead in the Finished Product	Additional aspects
Phoenix Contact and Harting	Spring contacts	Chip breaker, Internal lubricant	n.s.	Corrosion resistance, Low relaxation behaviour -> maintenance of contact forces	
	Crimp contacts		n.s.	Corrosion resistance, Ductility -> prevention of cracks.	
	Mechanical connecting parts such as e.g. gears		n.s.	Corrosion resistance, Wear resistance	

*: Framo Morat⁷¹⁶ explains on the load carrying capacity the following "The calculation of load-carrying capacity is an essential part of the designing of a drive including worm gears. To ensure a realistic computation several material properties have to be known. These properties relating to CuZn37Mn3Al2PbSi cannot be found in common literature like "Niemann/Winter - Maschinenelemente 3" or "Dubbel -Taschenbuch für den Maschinenbau". Therefore the used properties are based on decades of internal testing and recording. Framo is not able to perform any realistic and scientific proved calculation of load -carrying capacity, if CuZn37Mn3Al2PbSi will not be available for use anymore."

*Source: Bourns (2015b), LEU (2015b)*⁷¹⁷, *Phoenix Contact and Harting (2015a), Sensata (2015b)*

⁷¹⁶ Op. cit. Framo Morat (2014)

⁷¹⁷ Op. cit. LEU (2015b), LightingEurope (2015b), Answers to Clarification Questions, submitted 28.08.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Lighting_Europe/Ex_6c_LightingEurope1st_round_Clarification_LE_Ans_wers_20150828.pdf

20.3.1 **Possible Alternatives for Substituting RoHS Substances**

Bourns and **Sensata** both purchase components from suppliers, however, the efforts to stimulate the supply chain towards the development of possible alternatives to lead-containing copper alloys differs. Sensata⁷¹⁸ mostly leaves the responsibility on the component manufacturer and does not specify the efforts taken with *"existing materials, none of which has proven to be a suitable replacement"*. On the other hand, Bourns⁷¹⁹ indicates that they cooperate with their suppliers to explore possible solutions and they experiment with possible alternatives. Concerning alternatives tested and the respective problems, Bourns mentions the following alternatives (though not specifying the tests any further) that all *"have a higher raw material cost, a slower machining rate which reduces our capacity and shortens tool life"*:

- "Aluminium slow machining;
- Zinc die cast seal integrity issues;
- Nickel silver required slowing screw machine by 50%; material finish not as good as brass."

Bourns⁷²⁰ also mentions to have evaluated Ecobrass, but that it is not available in the required bar diameter size and was therefore not tested.

Dunkermotoren state that they have tested "*an alternative material. But the tests were negative. Now we restart the material search.*"

Framo Morat⁷²¹ also indicates to have tested *" for example ECOBRASS or other lead-free (0.1%) materials, were not satisfying. The substitutes did not reach the mechanical properties of the used one."* Framo Morat does not further specify the tested lead-free material.

LightingEurope⁷²² state that there are basically contact-pins made of lead-free alloys already available on the market by one supplier, but that the lighting industry has no experience with lead-free contact material: *"There is no evidence that lead-free materials cannot be used, but given the long life -time of lamps in combination with the mass scale application it also cannot be proven that lead-free contacts have the same performance regarding safety and reliability under all application conditions (current density, temperature, humidity etc.)." LEU also raises the concern that the current supply would not be able to satisfy the present demand of the market. LEU does not further specify the lead-free copper alloy.*

⁷¹⁸ Op. cit. Sensata (2015b): "The Sensata supply chain for lead-containing copper alloys comprises companies whose expertise is in stamping and screw-machining. Neither Sensata nor the Sensata supply chain have the expertise or resources to develop alternatives to lead-containing copper alloys." ⁷¹⁹ Op. cit. Bourns (2015b)

⁷²⁰ Op. cit. Bourns (2015b)

⁷²¹ Op. cit. Framo Morat (2014)

⁷²² Op. cit. LEU (2015b)

Phoenix Contact and Harting⁷²³ show some machining examples with substitutes. It is not always comprehensible whether e.g. publically funded research by RWTH Aachen or research conducted by the automotive industry is cited or whether own research is presented by Phoenix Contact and Harting; therefore the information submitted by Phoenix and Harting is rather seen as a generic review of the current EU industry opinion:

- A drilling test with CuZn42, a lead-free copper alloy with a higher zinc content, and the silicon-containing CuZn21Si3P resulted in only 3% of the required life of the drill compared to the leaded copper alloy CuZn39Pb3; the lead-free alloys also needed significantly higher cutting forces in the case of the lead-free alloys.
- Crimp contact made from the alloy CuZn42 showed continuous cracks during the crimping process, which are not allowed for a mechanically resistant and permanently safe connection: A crack permits the penetration of any corrosive substances. As a consequence the resistance increases and the contact point is heated up. Thus the risk of fire or unreliability exists. Besides, if a crack reduces the required mechanical pressure exerted on the cable, the pull-out force is below the required value as given in standards. The pulled out cable can apply power to touchable parts and thus a hazard for people is the potential consequence. Also, due to the broken connection, equipment (for example a motor) would fail.
- A gear pinion made with the lead-free copper alloy CuZn31Mn2Si1Al1 mechanically connected to a gear pinion made from plastic as part of a gear box showed a higher wear, as compared to a gear wheel made from CuZn39Pb3; the corresponding plastic pinions showed a much greater wear with the lead-free copper alloys pinion, which could cause a premature failure.

Phoenix Contact and Harting⁷²⁴ estimate that a connector pin as a simple component requires about 1000 labour hours for safety testing.

20.3.2 **Possible Alternatives for Eliminating RoHS Substances**

Two applicants mention the possibilities to use different materials:

 Bourns⁷²⁵ generally mentions that a possible alternative would be stainless steel that has a higher cost of machining. Machinability ratings indicate that stainless steel is 40-50% as efficient as brass because stainless steel as a poor conductor of heat compared to brass results in elevated temperatures during machining operations reducing the life of tools. Besides, Bourns mentions

⁷²³ Op. cit. Phoenix Contact and Harting (2015a)

⁷²⁴ Op. cit. Phoenix Contact and Harting (2015a)

⁷²⁵ Op. cit. Bourns (2015a)

that "rod sizes for screw machines are readily available in 360 brass; not available in stainless without more scrap/waste."

• Framo Morat⁷²⁶ mention that " in the early 2010s", it explored " new and high developed coatings like DLC or a particular shaped chrome layer. The first attempts had shown that there is a chance of potential in this technology to substitute CuZn37Mn3Al2PbSi. The continuation of this research would involve the generating of a non -assessable amount of costs and human resources. Anyway there are still future projects planned, which are connected to this technology."

20.3.3 Environmental Arguments

Phoenix and Harting⁷²⁷ state that "leaded brass is to nearly 100% made from recycled material. Without exemption 6c copper alloys for electric and electronic equipment could not, as it is common today, easily be made from recycled copper alloys. Thus the urban stock which is one of the most important sources for copper in Europe could not be used as it is possible today."

Within this context, the following environmental arguments are also provided by the applicants:

- **Framo Morat**⁷²⁸ explains that waste material from manufacturing is collected and stored in order for waste coolant to naturally drip from the material; then a specialized recycling company picks up the cuttings and centrifuges the last leftovers to remove remaining coolant. These dry cuttings are then sent to the material supplier who turns them back into new and usable work pieces. Framo Morat emphasises the certified and long -term reliable partnership with the material supplier.
- LightingEurope⁷²⁹ mentions that the waste stream of fluorescent lamps, responsible for about 70% of the total amount of lead in contact pins of lamps, has a specified take back system (see Section 4.3.3.3 in Lamp general chapter); other lamps that are sold in the consumer channel (mainly GU10 lamps) will not be recycled and are handled as normal waste; LEU estimates that about 50% of the TL-and CFLni lamps have been recycled in 2014 which suggests that 13.5 tons out of the 38 tons of lead were recycled via WEEE (i.e. accounting the 50% recycling rate with the 70% fluorescent lamps for which take back systems exist).

⁷²⁶ Op. cit. Framo Morat (2014)

⁷²⁷ Op. cit. Phoenix and Harting (2015a)

⁷²⁸ Op. cit. Framo Morat (2014)

⁷²⁹ Op. cit. LEU (2015a)

20.3.4 Socio-economic Impact of Substitution

Some applicants mention possible costs related to substitution, but in a general way, without further substantiating and quantifying possible impacts:

- **Bourns**⁷³⁰ claims an increase in direct production costs, however without providing further evidence.
- **Framo Morat**⁷³¹ mentions the profitability of the used copper alloy concerning the costs and lifetime of tools whereas the continuation of the research on substitutes "would involve the generating of a non-assessable amount of costs and human resources."
- LightingEurope⁷³² claims an increase in direct production costs and in fixed costs related to substitution: "Investments are necessary to switch-over from lead-containing to lead-free contact pins. Next to that the reject level (waste material) will be higher than with lead-containing copper alloy. There are no estimations on the total sum."

20.3.5 Road Map to Substitution

None of the applicants provide a road map for substitution.

20.4 Stakeholder Contributions

Twelve contributions to exemption 6c have been submitted during the stakeholder consultation. The contributions are presented in order of submission and are shortly summarized:

Mitsubishi Shindoh Co. Ltd.⁷³³ proposes Ecobrass as a lead-free copper alloy alternative, which has high strength, excellent machinability, exceptional wear resistance, good creep properties and superior corrosion resistance, as a replacement material for free-cutting brass rod CuZn38Pb3 suggesting that there is no difference in productivity from leaded brass. Mitsubishi Shindoh Co. Ltd.⁷³⁴ lists as examples of Ecobrass applications electrical and electronic component gears, terminals, medical devices and valves for electrical water heaters. The input of Mitsubishi Shindoh Co. Ltd. is further presented in section 20.5.2.

⁷³⁰ Op. cit. Bourns (2015a)

⁷³¹ Op. cit. Framo Morat (2014)

⁷³² Op. cit. LEU (2015a)

⁷³³ Mitsubishi (2015), Contribution by Mitsubishi Shindoh Co. Ltd., submitted 07.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Exemption_6c_</u> <u>2015-10-mitsubishi-shindoh-rohs.pdf</u>

⁷³⁴ Mitsubishi (2015), Contribution by Mitsubishi Shindoh Co. Ltd., submitted 07.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Exemption_6c_</u> <u>2015-10-mitsubishi-shindoh-rohs.pdf</u>

- **ODU GmbH & Co. KG**,⁷³⁵ a leading international manufacturer of connection systems, supports the renewal request by Phoenix Contact and Harting. ODU GmbH & Co. KG⁷³⁶ state that 95 % of their products would be affected if the exemption were not renewed and that they have made "serious efforts in direct cooperation with our raw material suppliers, until now, no material could be found that would even rudimentarily be suitable and bearable as a substitute. Of course, we are continuing our efforts in this area, but desperately need the additional time the extension would bring."
- GENBAND⁷³⁷ provides telecommunications equipment to many of the telecommunications companies in Europe and worldwide and supports the renewal of exemption 6c.

GENBAND⁷³⁸ points out that it purchases electrical components and products from other OEM manufacturers and therefore is not able comment directly on the technical aspects of material selection. GENBAND lists the following applications that need the use of leaded copper alloys: Connectors, power supplies, fans, heatsinks, electrical switches, potentiometers, EMI gaskets. GENBAND⁷³⁹ also corrected the mistake in the consultation questionnaire, which correctly should say " the lower relaxation behaviour achieved with leaded copper alloys maintains the contact forces in spring contacts", and points out the relation to fire risk if the contact fails: "The fire risk is created as the contact metal relaxes, causing the contact force to drop, increasing the contact resistance, increasing the heat in the connector, leading to melting and potentially fire."

- The Robert Bosch GmbH⁷⁴⁰ generally supports the applicants without providing further information.
- JBCE⁷⁴¹ Japan Business Council in Europe in a.i.b.l. states that they understand that EEE of category 8 and 9 are out of scope of this review. The JBCE

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Comment_on_p ublic_cousulation_of_Exemption_request_2015-2_6_c__.pdf

⁷³⁵ ODU (2015), Contribution by ODU GmbH & Co. KG, submitted 12.10.2015, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Stakeholder Co nsultation on RoHS Exemption 6c.pdf ⁷³⁶ ODU (2015), Contribution by ODU GmbH & Co. KG, submitted 12.10.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Stakeholder_Co nsultation_on_RoHS_Exemption_6c.pdf ⁷³⁷ GENBAND (2015), Contribution by GENBAND, submitted 14.10.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/EX_6c_GENBAN D_STAKEHOLDER_CONTRIBUTION.pdf

Op. cit. GENBAND (2015)

⁷³⁹ Op. cit. GENBAND (2015)

⁷⁴⁰ Robert Bosch GmbH (2015), Contribution by Robert Bosch GmbH, submitted 15.10.2015, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Bosch-Stakeholder-contribution-Exemption-request-6c.pdf ⁷⁴¹ JBCE (2015), Contribution by JBCE – Japan Business Council in Europe in a.i.b.l, submitted 15.10.2015,

available under:

understands that "the exemption 6(c) in annex III can be applied to category 8&9 products for seven years from identified date when entry into force for each products, at the earliest July 2021."

CETEHOR, the technical department of the Comite Franceclat (French Watch, Clock, Jewellery, Silverware & Tableware Centre)⁷⁴² explains that watch movements are 80 % made of leaded copper alloys (CuZn39Pb3). CETEHOR lists the following "extremely small parts" to be made of leaded copper alloys: plates, bridges, cogs, gears, screws, nuts, pins, pivots; their dimensional conformity have tolerances of 5 to 10 μ m. CETEHOR⁷⁴³ stated that these tight dimensional requirements are not met by lead-free copper alloys.

CETEHOR⁷⁴⁴ also claims that lead-free alternatives create a greater tool wear that needs a more frequent sharpening and higher consumption rates of tools and longer machining cycles required, which all cause financial problems.

CETEHOR⁷⁴⁵ estimated a quantity of lead of 120 kg per year based on the amount of 8 g of brass per watch for movement parts and the annual French production of quartz watches of 0.5 million.

ELTECNO,⁷⁴⁶ a producer of low-voltage switchgear and control gear assemblies, supports the renewal of the exemption with a content of lead in copper of 4%. ELTECNO uses leaded copper alloy for the terminals for the protective conductors and sometimes for the neutral conductors. ELTCNO⁷⁴⁷ mentions the favourable machining properties but also corrosion resistance as performance requirement of leaded copper alloys.

ELTECNO⁷⁴⁸ indicates the following amounts of leaded copper alloys with a lead content of 3.3% used: 1.5 tpa, resulting in 47 kg lead per year.

HARTING KGaA⁷⁴⁹ discussed in its contribution the information provided by Dunkermotoren and Framo Morat that both indicate the use of a leaded copper alloy with a lead content of <1%. Harting KGgA stresses that both have used these alloys before and that their applications are very specific ones.

⁷⁴² CETEHOR (2015), Contribution by Comite Franceclat (French Watch, Clock, Jewellery, Silverware & Tableware Centre), CETEHOR, submitted 15.10.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Ex_6.c_Comite Franceclat_Cetehor_20151012.pdf ⁷⁴³ Op. cit. CETEHOR (2015)

⁷⁴⁴ Op. cit. CETEHOR (2015)

⁷⁴⁵ Op. cit. CETEHOR (2015)

⁷⁴⁶ ELTECNO (2015), Contribution with picture by ELTECNO, submitted 19.10.2015, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Ex_6c_ELTECNO

Answers 20151016.pdf ⁷⁴⁷ Op. cit. ELTECNO (2015)

⁷⁴⁸ Op. cit. ELTECNO (2015)

⁷⁴⁹ HARTING al. (2015a), Contribution by HARTING KGaA et al., submitted 19.10.2015, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Ex_6c_HARTING _KGaA__stakeholder_consultation_2015-10-16.pdf

As for properties of lead, HARTING KGgA et al.⁷⁵⁰ adds the following: *"electrical conductivity, thermal conductivity, cold deforming behaviour, resistance welding, galvanizing ability, soldering at higher temperatures than 450 °C, relaxation behaviour, crimp ability, spring behaviour, high-speed stamping, physical properties (melting point, coefficient of thermal expansion, etc.), fabrication process properties (hot forming, brazing, etc.), etc." HARTING KGgA et al.⁷⁵¹ stresses that these properties as well as their interrelations <i>"cannot be seen as independent from the application"*.

- HARTING KGaA⁷⁵² submitted a response to the contribution of Mitsubishi Shindoh; this input is discussed in section 20.5.2.

• **KEMI** Kemikalieinspektionen, the Swedish Chemicals Agency⁷⁵³, interprets Article 5 in the RoHS Directive in the way that both the material or component and the specific applications need to be defined in the wording formulation of an exemption. Thus, *"it is no longer legally possible to decide on an exemption for lead in copper alloys whatever the use is."*

KEMI⁷⁵⁴ therefore proposes the split into a number of more specific exemptions related to applications where it has been verified that feasible alternatives are currently not available. KEMI⁷⁵⁵ extracted the specific applications that were mentioned by the different applicants, further discussed in section 20.5.5.

• **PennEngineering**, ⁷⁵⁶ a designer and manufacturer of specialty fasteners, supports the renewal request, however states that it agrees with a lower threshold of 2.5% than the current 4.0 % because they have found *" 353 to be an acceptable alternative to 360"*.

PennEngineering⁷⁵⁷ explains that leaded brass offers the advantages in their machining environment (multi-spindle automatic screw machines or single spindle CNC lathes) of significantly longer tool life leading to higher efficiency (less downtime), better surface finish, significantly higher surface speed and

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Ex_6c_HARTING <u>KGaA_response_Mitsubishi_Shindoh_2015-10-16.pdf</u> ⁷⁵³ KEMI (2015),Contribution by KEMI Kemikalieinspektionen, Swedish Chemicals Agency, submitted

⁷⁵⁰ Op. cit. HARTING et al. (2015a)

⁷⁵¹ Op. cit. HARTING et al. (2015a)

⁷⁵² HARTING et al. (2015b), Contribution by HARTING KGaA et al. as a response to the contribution of Mitsubishi Shindoh, submitted 19.10.2015, available under:

⁷⁵³ KEMI (2015),Contribution by KEMI Kemikalieinspektionen, Swedish Chemicals Agency, submitted 19.10.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Ex_6c_KEMI_An_swer_to_SC_RoHS_20151016_Lead_in_copper.pdf

⁷⁵⁴ Op. cit. KEMI (2015)

⁷⁵⁵ Op. cit. KEMI (2015)

⁷⁵⁶ PennEngineering (2015), Contribution by PennEngineering, Danboro, PA, USA, submitted 19.10.2015; available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Ex_6c_PennEngi neering_Consultation_Questionnaire_PE_AS_20151016.pdf

⁷⁵⁷ Op. cit. PennEngineering (2015)

significantly higher feed rate. PennEngineering stated that they have experimented with lead-free Ecobrass and found it to machine significantly worse than 353 leaded brass, however do not provide further evidence. PennEngineering⁷⁵⁸ states that they currently use 190.5 t ("420,000 lb") of the two different leaded copper alloys (353 and 360) per year globally; the amount of the contained lead is calculated at 3.86 tpa ("8,500 lb"). PennEngineering estimated that approximately 25% of its sales of leaded product go to EEE in the FU.

The Test & Measurement Coalition⁷⁵⁹ submitted a general contribution on Category 9 Industrial monitoring and control instruments, similar in nature to the contribution made by the JBCE.

20.5 Critical Review

20.5.1 **REACH Compliance - Relation to the REACH Regulation**

Appendix A.1.0 of this report lists Entry 30 in Annex XVII of the REACH Regulation, stipulating that lead and its compounds shall not be placed on the market, or used, as substances, constituents of other substances, or in mixtures for supply to the general public. A prerequisite to granting the requested exemption would therefore be to establish whether the intended use of lead in this exemption request might weaken the environmental and health protection afforded by the REACH regulation.

In the consultants' understanding, the restriction for substances under Entry 30 of Annex XVII does not apply to the use of lead in this application as lead is used as an alloying element. Copper alloys are used to produce various components and articles. In the consultants' point of view this is not a supply of a lead as a substance, mixture or constituent of other mixtures to the general public. Pb is part of an article and as such, Entry 30 of Annex XVII of the REACH Regulation would not apply.

Appendix A.1.0 of this report lists Entry 63 in Annex XVII of the REACH Regulation, stipulating that lead and its compounds shall not be placed on the market or used in articles supplied to the general public, if the concentration of lead (expressed as metal) in those articles or accessible parts thereof is equal to or greater than 0,05 % by weight, and those articles or accessible parts thereof may, during normal or reasonably foreseeable conditions of use, be placed in the mouth by children.⁷⁶⁰ Entry 63 however further specifies this restriction not to be applicable for articles within the scope of the RoHS Directive 2011/65/EU.

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_1_ae /General Contribution Test Measurement Coalition package 9 exemptions 20151016.pdf ⁷⁶⁰ Other restrictions of entry 63 cover e.g. jewellery and are thus not applicable here.

⁷⁵⁸ Op. cit. PennEngineering (2015)

⁷⁵⁹ Test & Measurement Coalition (2015), Contribution by Test & Measurement Coalition, submitted 19 October 2015, available under:

No other entries, relevant for the use of lead in the requested exemption could be identified in Annex XIV and Annex XVII (status January 2016).

Based on the current status of Annexes XIV and XVII of the REACH Regulation, the requested exemption would not weaken the environmental and health protection afforded by the REACH Regulation. An exemption could therefore be granted if other criteria of Art. 5(1)(a) apply.

20.5.2 Scientific and Technical Practicability of Substitution

Mitsubishi Shindoh Co. Ltd.⁷⁶¹ submitted a contribution to the consultation pointing out the lead-free copper alloy Ecobrass as a substitute material for many components, especially where high electrical conductivity is not critical although it is not possible for Ecobrass to replace all leaded copper alloys. According to Mitsubishi,⁷⁶² Ecobrass is used mostly as replacement material for free-cutting brass rod CuZn38Pb3 suggesting that there is no difference in productivity from leaded brass. Durability and corrosion resistance in various environments such as in soil or hot-humid conditions have also been validated.

As for examples of Ecobrass' applications for electrical and electronic components, Mitsubishi⁷⁶³ list gears, terminals, medical devices, and valves for electrical water heaters.

Mitsubishi⁷⁶⁴ also argue that Ecobrass has been adopted for the sliding component of vehicle air conditioner replacing C36000 and that the machining example of vehicle components is a model case for substituting small electrical and electronic components. Besides, Mitsubishi⁷⁶⁵ argues that components used in large electrical home appliances are similar to valves and fittings used in drinking water fixtures and components.

For the suitability in electrical applications where the components require conductivity, which is understood to be the case for e.g. contact pins (applied for by LightingEurope), crimp contacts (mentioned by Phoenix Contact and Harting) or switch gears (mentioned by ELTECNO) or terminals (mentioned by Bourns), Mitsubishi states that *"Ecobrass can replace leaded-brass for high conductivity applications by plating with such materials as Ag or Sn, which is applicable for many components."* E.g. Mitsubishi⁷⁶⁶ mentions terminals to be manufactured from Ecobrass. Electrical conductivity is provided by silver plating that is applied after the machining process. According to Mitsubishi,⁷⁶⁷ Ecobrass has been selected for terminals since 2005 and the total sales volume has reached 35

⁷⁶¹ Op. cit. Mitsubishi (2015)

⁷⁶² Op. cit. Mitsubishi (2015)

⁷⁶³ Op. cit. Mitsubishi (2015)

⁷⁶⁴ Op. cit. Mitsubishi (2015)

⁷⁶⁵ Op. cit. Mitsubishi (2015)

⁷⁶⁶ Mitsubishi (2016), Mitsubishi Shindoh Co. Ltd. (2016), Answers to Clarification Questions, submitted 15.01.2016.

⁷⁶⁷ Op. cit. Mitsubishi (2016)

tones. Mitsubishi⁷⁶⁸ indicates that the sizes of material in use are ϕ 5, 7 and 9 mm and continues to explain that "assuming the size of material is ϕ 7×40 mm, more than 2,500,000 products have been manufactured." The following figure shows a picture of the Ecobrass terminal.

Figure 20-1: Terminals made of ecobrass



Source: Mitsubishi (2016)

For applications where high conductivity is required, Mitsubishi recommends other leadfree copper alloys such as C18625, a high copper alloy that has a high electrical conductivity with strength equal to or exceeding leaded brass.

On Ecobrass, the applicants and the contributing stakeholder provided the following objections:

- Bourns⁷⁶⁹ explains that in January 2001, Ecobrass was evaluated for machining capability and that the plant had difficulty in machining this material at that time. As a recent problem, Bourns stated that Ecobrass is not available in small diameter bars: *"Some trimming potentiometers require a diameter size of 0.075. Using a 0.250" would mean 91% waste if machined down to 0.075."*
- GENBAND states " The Mitsubishi –Shindoh in their contribution indicate that electrical and thermal conductivity are affected by the lead content. This makes their material not suitable for electrical conductors."
- Framo Morat⁷⁷⁰ explains that "first tests with possible substitutes, for example Ecobrass or other lead-free (<0.1%) materials, were not satisfying. The substitutes did not reach the mechanical properties of the used one."
- PennEngineering "have experimented with lead-free Ecobrass and found it to machine significantly worse than 353 leaded brass."

From the objections above it is apparent that the machining processes cannot be equally run. This problem was also discussed during the ELV revision of the corresponding exemption, wherein the consultants could follow that Ecobrass may suffer technical drawbacks that still delay their implementation, e.g. in the case of Ecobrass, for

⁷⁶⁸ Op. cit. Mitsubishi (2016)

⁷⁶⁹ Op. cit. Bourns (2015a)

⁷⁷⁰ Op. cit. Framo Morat (2014)

micromachining in automated series production. During the ELV revision Mitsubishi⁷⁷¹ submitted a drilling report that used a different drilling bit (carbide compared to high speed steel) that suggests how machining processes could be adapted to process Ecobrass. These adaptations are important in cases where machining knowledge on these alloys or usability of required equipment for these alloys is a key requirement for successful application. The automotive industry argued during the ELV revision that machining and processing of alternative alloys is in a very basic research stage because public funded research on fundamental parameters is still on-going in the field of machining. Welter⁷⁷² stated in a report compiled on behalf of the automotive industry that there is little know-how among the subcontractors specialized in micromachining and their tool suppliers and machining companies:

"The subcontractors specialised in the field of micro-machining are in general small or medium size companies. Usually they do not have the competences and resources to do the development needed for low cost, high volume production. They have to rely on external expertise and education. Apparently, until now, no activities were started aiming to define the machining parameters for lead-free copper alloys. For instance, in France, the Centre Technique de l'Industrie du Décolletage (CTDec) starts to be active when their members come up with specific demands for assistance. The CTDec has developed testing recommendation and sensors for evaluating new materials. The opinion is that the machining shops could rapidly gain their own experience by using these helps and try to deal with lead-free brasses. Besides the loss of productivity, the major problems will be the need to invest in more rigid equipment, to develop software for adjusting the rotation speeds of the machine e.g. to the different steps of the drilling process, as well as to find more convenient cutting tools. Unfortunately, tools have arrived nowadays at a mature level and there is little margin for innovation. In the USA and Germany first publications are coming up in specialised magazines giving some hints how to work with such alloys. Thus, in the USA a paper was published in 2009 discussing the problems occurring when machining lead-free and low-lead brass with 0.25 % of lead (the paper aimed at plants fabricating plumbing fittings and fixtures for the Californian market): the point was that these alloys should not be run like leaded brass, but rather like steel (Free 2009). The paper made some general recommendations, but without giving any detailed information. The same holds for the educational courses organised since 2013 by the German copper trade association (Deutsches Kupferinstitut). Furthermore, some brass mills start

⁷⁷¹ Mitsubishi (2015b), Mitsubishi Shindoh Co., Ltd., Micro-Drilling test report; submitted by Email 13 March 2015 during revision of the ELV exemption.

⁷⁷² Welter (2014) Jean-Marie Welter: Leaded copper alloys for automotive applications: a scrutiny; European Copper Institute, November 20, 2014; submitted as Annex 2 with the contribution of ACEA et al. (2014);

http://elv.exemptions.oeko.info/fileadmin/user_upload/Consultation_2014_1/Ex_3/E3_02_Welter_201 4_leaded_copper_alloys_for_automotive_applications-a_scrutiny.pdf
also to provide general information about machining (mainly macro-machining) the lead-free brasses. Nevertheless the overall perception is that presently machining shops can expect very little support from outside. Thus the forced modification of processing technologies will lead to a distortion of the market to the profit of large machining companies or of speciality machining shops. It is neither very clear whether the lath, tool and lubricant manufacturers have yet started to develop specific equipment and ancillaries for dealing with these new alloys in a productive way. It will still take many years until both the necessary know-how will be obtained and spread on a larger scale and the money will be available to invest into the production tools adapted to the new situation."

A German research project⁷⁷³ on the improvement of the machinability of lead-free copper alloys developed concrete solutions and approaches that comprise adaptations of tool geometries, targeted supply of coolant lubricant in order to provide chip breaking and improve the process reliability. The use of adapted cutting materials (polycrystalline diamond) and tool coating (diamond coatings) provides significantly increased tool life and reduces the rate of metal removal. Productivity was additionally increased by the use of cutting plates with wiper geometry.⁷⁷⁴

To conclude, it is understood that there may currently still be some restrictions on putting lead-free copper alloys such as Ecobrass into successful applications. The process for adapting machining might take time but it is understood that it basically can be overcome in the future for at least some applications.

Generally, the assessment of scientific and technical practicability of substitution of lead in copper alloys is hampered by the fact that Phoenix Contact and Harting who applied for the renewal of the exemption on behalf of 26 EEE organisations and associations did not provide an exhaustive or even indicative overview on the different applications of leaded copper alloys in EEE. Asked for initiatives among the different industry associations and companies to set up an inventory for applications of leaded copper alloys in the future defining key requirements that are provided by leaded copper alloys, Phoenix Contact and Harting state:⁷⁷⁵

"There is no such inventory and it is also not planned to set up an inventory. The manufacturers that use leaded copper alloys belong to completely different industries. There is some collaboration between the manufacturers and the associations. But as RoHS is applicable to all EEE the associations have completely different members and the overlap is often quite small. It has to be noticed that such an inventory would contain many sensitive data and companies will not be

 ⁷⁷³ Nobel & Klocke (2013), Nobel, C., Klocke, F. (2013), Zerspanen bleifreier Kupferwerkstoffe; IGF-Forschungsvorhaben 16867 N, available in German under: http://publications.rwth-aachen.de/record/230384/files/4856.pdf
 ⁷⁷⁴ According to Nobel & Klocke (2013), wiper plates have a larger nose radius that allows high feed rates

⁷⁷⁴ According to Nobel & Klocke (2013), wiper plates have a larger nose radius that allows high feed rates and results in a good surface quality.

⁷⁷⁵ Op. cit. Phoenix Contact and Harting (2016)

able to give these data to others. Thus there will not be such an inventory where one could make an overview over all components or EEE with leaded copper alloys."

When asked to exhaustively specify the functionality of lead in EEE applications and to name performance indicators where possible which would allow assessing substitutes in the future, Phoenix Contact and Harting state:⁷⁷⁶

"As shown before the required properties of a material depend on the application and the environment the item will be used in. Thus it is not possible to give a general performance indicator for a material. Not all properties are relevant for all applications and every application will require different properties. Often these properties are not standardized values but it is the specific experience and expertise of the manufacturer. So there is no simple correlation that would allow defining performance indicators."

The consultants understand that there could be a large variety of different components in different surrounding conditions. However, the consultants are of the opinion that an inventory will help to define application groups to deduce the relevant properties. For example, during the ELV revision, the automotive industry⁷⁷⁷ proposed as application groups for leaded copper alloys "sliding elements", "electric elements" and "mechanical connecting elements". The consultants expect that such an inventory would help to identify specific components in the future that could be evaluated as to the applicability of substitutes or of alloys with lower lead content.

20.5.3 **Possible Alternatives for Eliminating or Reducing RoHS Substances**

In this section there are two possibilities discussed, using different material in order to eliminate the use of lead or using leaded copper alloys with a lower lead content in order to reduce the use of lead.

The applicant Bourns⁷⁷⁸ generally mentions that a possible alternative would be stainless steel, but claims that this has a higher cost of machining. Bourns does not specify the components where stainless steel could be used as a substitute. The consultants understand from the other alloy exemptions under RoHS that small connecting components, such as hex nuts or screws for example, are also manufactured by leaded steel and leaded aluminium alloys. Therefore in applications where the components have mechanically connecting functions and where the lead does not provide a function in the finished article, the use of different material should be explored.

⁷⁷⁶ Op. cit. Phoenix Contact and Harting (2016)

ACEA et al. (2014), ACEA, JAMA, KAMA, CLEPA and EAA (2014a), Industry contribution of ACEA, JAMA, KAMA, CLEPA and EAA, submitted during the online stakeholder consultation, retrieved from http://elv.exemptions.oeko.info/fileadmin/user_upload/Consultation_2014_1/Ex_3/20141210_ACEA_Ann exll_3.pdf ⁷⁷⁸ Op. cit. Bourns (2015a)

PennEngineering⁷⁷⁹ claimed in its contribution that they achieved using a lower leaded copper alloy and therefore agree to lower the lead threshold of the exemption down to 2.5% from the current 4.0%. However, from the information provided from the applicants and from the stakeholders submitting contributions a lower threshold of lead cannot be unambiguously defined for all applications. The consultants understand that it might generally be applicable for mechanically moving components. This assumption is based on the one hand on the information provided by Framo Morat and Dunkermotoren, which use leaded copper alloys with a lead content of < 1% for their gear parts. However, information provided by the automotive industry⁷⁸⁰ during the ELV revision showed that applications with a low lead content in copper alloys are within the "sliding elements" and "mechanical connecting elements" application groups (close to 0.3% Pb within sliding elements and 0.2% Pb within mechanical connecting elements). It might, however not be the case for all mechanically moving components: CETEHOR⁷⁸¹ claims to use the alloy CuZn39Pb3 for their extremely small parts. Phoenix Contact and Harting⁷⁸² added information that for watch components the possibility for drymachining provided by lead is an important performance requirement while for leadfree alloys lubricants are required. To conclude, the consultants propose that the use of lower leaded copper alloys should systematically be explored where the use of lead-free alloys is not practical.

20.5.4 Environmental Arguments

The environmental arguments mentioned by the applicants relate to particular aspects of e.g. the recycling of fluorescent lamps, or to very general ones, such as the importance of copper recycling. Such aspects are not further discussed here as they do not provide insight as to the comparison of leaded copper alloys with lead-free ones in relation to environmental impacts.

20.5.5 Stakeholder Contributions

Five contributions were submitted to the stakeholder consultation. The contributions of KEMI,⁷⁸³ CETEHOR⁷⁸⁴ and PennEngineering⁷⁸⁵ are discussed in the sections above as well as below.

⁷⁷⁹ PennEngineering (2015), Contribution by PennEngineering, Danboro, PA, USA, submitted 19.10.2015; available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6_c_/Ex_6c_PennEngi neering_Consultation_Questionnaire_PE_AS_20151016.pdf

⁷⁸⁰ Op. cit. ACEA et al. (2014)

⁷⁸¹ Op. cit. CETEHOR (2015)

⁷⁸² Op. cit. Phoenix Contact and Harting (2015a)

⁷⁸³ Op. cit. KEMI (2015)

⁷⁸⁴ Op. cit. CETEHOR (2015)

⁷⁸⁵ Op. cit. PennEngineering (2015)

The contributions submitted by TMC⁷⁸⁶ and JBCE⁷⁸⁷ raise a legal question as to the availability of the current exemption to category 8 and 9 equipment. TMC and JBCE claim the availability of Annex III exemptions to category 8 and 9 for seven years starting in 22.7.2017.

Phoenix Contact and Harting⁷⁸⁸ state in this regard:

"We apply for renewal of this exemption for categories 1 to 7, 10 and 11 of Annex I for an additional validity period of 5 years. For these categories, the validity of this exemption may be required beyond this timeframe. Although applications in this exemption renewal request may be relevant to categories 8 & 9, this renewal request does not address these categories."

As leaded copper alloys are understood to be relevant to all categories, it can be concluded that expiration dates should be specified for all categories.

20.5.6 The Scope of the Exemption

The scope of the current exemption is viewed as very wide. As mentioned above, the contribution of the Swedish Chemicals Agency KEMI makes reference to Article 5(1)(a) that stipulates an inclusion of materials and components of EEE for specific applications in the lists in Annexes III and IV. The specification of applications is understood not to be exhaustive for Ex. 6c. KEMI therefore proposes to split into a number of more specific exemptions, related to applications where it has been verified that feasible alternatives are currently not available. Though the consultants agree with the need to narrow the scope of the exemption, it is presently not possible to comprehensively conclude specific applications to narrow the scope of the exemption. Phoenix Contact and Harting⁷⁸⁹ explain that "in most cases the component manufacturer chooses the material due to the characteristics required for the specific component. The EEE manufacturer uses this component to build the EEE. As in the supply chain, often several stages between the component manufacturer and the EEE manufacturer exist the component manufacturer often does not know in which applications the component is used. On the other hand the EEE manufacturer normally does not know for which specific reasons the component manufacturer chose the material as this is the specific know-how of the component manufacturer." This is similar to the situation of leaded steel alloys in Ex. 6a. Therefore a comparable approach will also be discussed for the leaded copper alloys, as follows below.

The consultants would expect that the scope could be narrowed based on application groups or based on critical properties and required performance in application groups. This could require a supply chain survey, in order to collect and compile relevant

⁷⁸⁶ Op. cit. TMC (2015)

⁷⁸⁷ Op. cit. JBCE (2015)

⁷⁸⁸ Op. cit. Phoenix Contact and Harting (2015a)

⁷⁸⁹ Op. cit. Phoenix Contact and Harting (2015b)

information and to allow conclusions as to relevant properties and performance levels. Time may be needed in order to initiate such a survey along the supply chain to gain this information and screen all relevant applications relevant to arrive at an exhaustive list (of applications or of properties). However, this effort is presumed to be feasible as well as important for communicating to the customers where additional effort is needed in the applications of substitutes in the future.

As in the case of leaded steel alloys, in the case of leaded copper alloys the applicants Phoenix Contact and Harting⁷⁹⁰ also point out the individual and specific situation of each machining company: *"For example the machinability is not one isolated property but it depends on material, tool, coolant, machining technology and of course of the part that is to be made. Thus the change of one parameter also causes changes in the other parameters."*

Therefore it might be that an exhaustive list of properties also specifying the required performance level and the relevant performance indicators that are relevant for such properties might not be practicable to refine the scope of the exemption. To support this understanding, however, the complexity of the situation at hand needs to be presented and substantiated. The wide scope currently addressed in the exemption is open to misuse in cases where substitution might be possible. Therefore the consultants conclude that although a comprehensive list of applications may be long for refining the scope of the exemption, this is however of importance for establishing the potential of a change in scope. The consultants consider this to be the first step to further narrow the scope of the exemption, which the industry must be induced to undertake.

20.5.7 Exemption Wording Formulation

As with the other alloy exemptions, the need to narrow down the exemption is evident. However, at this time on the basis of the available information the consultants cannot conclude a list of exhaustive applications of leaded copper alloys, which would be a prerequisite for narrowing the exemption.

20.5.8 Conclusions

Article 5(1)(a) provides that an exemption can be justified if at least one of the following criteria is fulfilled:

- their elimination or substitution via design changes or materials and components which do not require any of the materials or substances listed in Annex II is scientifically or technically impracticable;
- the reliability of substitutes is not ensured;
- the total negative **environmental**, **health and consumer safety impacts** caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof.

⁷⁹⁰ Op. cit. Phoenix Contact and Harting (2015b)

The consultants understand from the information provided that there are substitutes available that could at least be used for some applications. However, the use of alternatives (e.g. Ecobrass) requires adaptations in the machining process. Consequently, substitution with Ecobrass is currently understood to have restrictions limiting its applicability to certain applications, and possibly requiring machining adaptations in others. There are results from publically funded research that suggest how to overcome machinability challenges. Therefore it can be assumed that at least for some applications, the machining problems can be overcome in the future. It can be understood that there are additional lead-free copper alloys; however information was not provided in relation to other specific alloys.

It is further noted that though the applicants and stakeholders provide some detail as to their efforts towards substitution, in most cases statements remain general in nature. Quantitative comparisons are not sufficiently available to allow comparing between leaded alloys and various lead-free candidates in relation to various application sub-groups.

The remaining applications have to be specified by performing an integrated survey of the supply chain in order to narrow the scope of the exemption to a comprehensive list of applications. This would need the engagement of EEE component manufacturers as different applicants mentioned the dependency of the supply chain. The consultants can follow that this would be time-consuming. However, the consultants think that the current scope is not justified and recommend a short-term exemption to allow performing such a survey.

The set-up of a comprehensive list of applications would also allow deciding, whether the lead content can be further reduced in a certain application range. It might be that for a specific application group a general lower lead threshold can possibly be achieved.

20.6 Recommendation

Based on the above considerations, it can currently not be concluded whether substitution of the use of copper alloys containing lead up to 4% by weight is scientifically or technically practicable. It appears that substitutes can be applied in some cases (lead-free or with lower lead content), however mutual factors that would allow conclusions for specific sub-groups cannot currently be identified. It can also be understood that at least in some cases, available substitutes cannot be applied.

The overall picture where substitution efforts are promising is not clear enough at present. The aim of a future review should therefore be an exhaustive inventory on the applications of leaded copper alloys together with their technical requirements in order to check the applicability of a more narrow scope for the exemption. This should also encourage machining process adaptation to be further investigated to process lead-free [and/or reduced lead] alloys. Various stakeholders explain that such a survey would not be practical; however it is the obligation of the applicants (and of stakeholders interested in the exemptions renewal) to provide sufficient information to justify exemptions and their renewal.

Thus, the consultants recommend the renewal of Exemption 6c with the current scope and wording. However to stress the need to set up such an inventory and to start an integrated approach and to initiate a comprehensive survey along the value chain with a view to, at least, identify lists of components or categories of applications for lead reduction or substitution, the consultants propose to set a short review period of three years. As it does not seem that most stakeholders have detailed plans as to how to promote substitution in the future, the consultants would further recommend cancelling the exemption, should industry fail to provide substantiated information in the future.

Exemption 6c	Duration*
	For Cat. 1-7 and 10 and 11: 21 July 2019
	For Cat. 8 and 9: 21 July 2021
Copper alloy containing up to 4% lead by weight	For Sub-Cat. 8 in-vitro: 21 July 2023
	For Sub-Cat. 9 industrial: 21 July 2024

Note: As it can be understood that the exemption duration may vary for various categories on the basis of Article 5(2), expiration dates have been specified here for all categories either on the basis of the requested duration in the exemption request which the consultants perceive to be justified, or on the basis of the validity periods specified in Article 5(2) for categories, which are newly in scope.

20.7 References Exemption 6c

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- Phoenix Contact and Harting (2016) PHOENIX Contact GmbH&Co. KG and HARTING KGaA, Answers to 2nd Clarification Questions, submitted 29.01.2016.
- Robert Bosch GmbH (2015) Contribution by Robert Bosch GmbH, submitted 15.10.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/

user_upload/RoHS_Pack_9/Exemption_6_c_/Bosch-Stakeholder-contribution-Exemption-request-6c.pdf

- Sensata (2015a) Sensata Technologies Holland B.V., Original Application for Exemption Renewal Request, submitted 15.01.2015, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/ RoHS_Pack_9/Exemption_6_b_/Sensata/6a_6b_6c_RoHS-Exemptions_Application-Format_Ex_6a_b_c_Pb_in_St_Al_Cu.pdf
- Sensata (2015b) Sensata Technologies Holland B.V., Answers to Clarification Questions, submitted 20.08.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_6 _c_/Sensata/Ex_6a6b6c_Sensata_Questions_response_20150820.pdf

TMC (2015) Contribution by Test & Measurement Coalition, submitted 19.10.2015, available under: http://rohs.exemptions.oeko.info/ fileadmin/user_upload/RoHS_Pack_9/Exemption_1_ae_/General_Contribution_Test___Measurement_Coalition_package_9_exemption

e_/General_Contribution_Test___Measurement_Coalition_package_9_exemptions_2 0151016.pdf

Welter (2014) Jean-Marie Welter, Leaded copper alloys for automotive applications: a scrutiny; European Copper Institute, 20 November 2014; submitted as Annex 2 with the contribution of ACEA et al. (2014);

http://elv.exemptions.oeko.info/fileadmin/user_upload/

Consultation_2014_1/Ex_3/E3_02__Welter_2014_leaded_copper_alloys_for_autom otive_applications-a_scrutiny.pdf

26.0 Exemption 9: "Hexavalent chromium as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0,75 % by weight in the cooling solution"

Declaration

In the sections that precede the "Critical Review" the phrasings and wordings of stakeholders' explanations and arguments have been adopted from the documents provided by the stakeholders as far as required and reasonable in the context of the evaluation at hand. Formulations have been altered in cases where it was necessary to maintain the readability and comprehensibility of the text. These sections are based exclusively on information provided by applicants and stakeholders, unless otherwise stated.

Acronyms and Definitions

CrVI	Hexavalent chromium
CrIII	Trivalent chromium
ECHA	European Chemicals Agency
EEE	Electrical and electronic equipment
ELV	End-of-life vehicle
EoL	End-of-life
EU COM	European Commission
RAC	Risk Assessment Committee
RV	Recreational vehicles
SEAC	Socio-Economic Analysis Committee
ТМС	The Test and Measurement Coalition

26.1 Background

According to the applicant,¹⁴⁷⁰ absorption refrigerators are used in recreational vehicles (RV), marine applications, camping boxes and mobile cooling boxes for medical purposes¹⁴⁷¹ and generally in cases of restricted space e.g. for hotel minibars, in lodges and small apartments, because they operate silently and vibration-free. Absorption refrigerators can be run on different energy sources like electricity, kerosene or gas. Some products are designed to run on variable energy sources. The noiseless operation and the possibility to switch between the energy sources are the important performance criterion according to the applicant.

In absorption refrigeration, a heat source (e.g. gas or electricity) is used to separate the ammonia from the water that then enters the evaporator where the presence of hydrogen lowers the ammonia vapour pressure sufficiently to allow the liquid ammonia to evaporate. The evaporation of the ammonia extracts heat from the air, thereby lowering the temperature inside the refrigerator.¹⁴⁷² This is schematically shown in the following figure.

¹⁴⁷⁰ Dometic (2015a), Original Application for Exemption Renewal Request, submitted 20.01.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_9/9_150120_RoHS_V _Application_Form_Dometic.pdf

Dometic (2015c), Dometic GmbH, Analysis of Alternatives and Socio-Economic Analysis, available under http://echa.europa.eu/documents/10162/0783ee3a-7de9-45ec-a72a-c1689ee49e09

¹⁴⁷¹ For e.g. transportation of vaccine and blood according to Dometic (2015c)

¹⁴⁷² Op. cit. Dometic (2015c)



Figure 26-1: Absorption cooling system schematic

Source: Dometic (2015c)

Hexavalent chromium (CrVI) acts as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators. According to the applicant¹⁴⁷³, CrVI is used to create a thin and tight layer on the interior surface of the steel tubes to protect them from the cooling solution that contains corrosive ammonia. The cooling system is comprised from carbon steel because of its strength and its good welding- and cold-working properties.

Dometic has submitted a request for the renewal of Ex. 9:

"Hexavalent chromium as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0,75 % by weight in the cooling solution"

Dometic requests an extension of the exemption for another three years in order to finalize substitution with an alternative corrosion inhibitor in the absorption refrigerator

¹⁴⁷³ Op. cit. Dometic (2015a)

range of products falling under RoHS. According to the applicant¹⁴⁷⁴, most of the products used in the lodging industry and in private homes are covered by the RoHS Directive. The applicant¹⁴⁷⁵ states that products falling under the RoHS Scope belong to category 1.

The applicant further explains that products for recreational vehicles (RV) and marine applications with absorption technology are most often specifically designed for that purpose and thus fall outside of the scope of RoHS. Several products for RV fall within the scope of the ELV-directive.¹⁴⁷⁶ A corresponding exemption is available under the ELV Directive (2000/53/EC, Annex II, Ex. 14) and is formulated as follows:

"As an anti-corrosion agent of the carbon steel cooling system in absorption refrigerators in motorcaravans up to 0,75 weight % in the cooling solution except where the use of other cooling technologies is practicable (i.e. available on the market for the application in motor caravans) and does not lead to negative environmental, health and/or consumer safety impacts".

26.1.1 History of the Exemption

During the last revision of Exemption 9, the same wording was proposed as under the ELV Directive mentioned in the para above.¹⁴⁷⁷ It was understood that research and development of alternatives for CrVI was still underway and required additional time. Furthermore, alternative cooling technologies such as thermoelectric refrigeration and compressor refrigeration that do not need CrVI were discussed during the last revision. At the time, Dometic stated that for some areas of use compressor-based alternatives are available. However, being noisier than absorption refrigerators, this may be a health concern for some consumers. Though noise could possibly be mitigated through design changes, it was further understood that small-scale compressor-based refrigerators are only available for a small number of applications, starting with approximately 80 I, and thus not suited as e.g. built-in minibars of approximately 40 I. Thus it was concluded at the time that such compressor-based units cannot be used as alternatives on the system level to eliminate the need for absorption refrigerators using CrVI as a corrosion resistance agent. The renewal of the exemption was therefore recommended, resulting in the exemption currently listed in Annex III.

¹⁴⁷⁴ Dometic (2015b), Answers to Clarification Questions, submitted 13.08.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_9/20150813_Ex_9_D</u> <u>ometic_replay_on_questions.pdf</u>

¹⁴⁷⁵ Op. cit. Dometic (2015a)

¹⁴⁷⁶ Op. cit. Dometic (2015b)

¹⁴⁷⁷ Gensch, et al. (2009), Carl-Otto Gensch, Oeko-Institut e. V., et al. 20 February 2009, Adaptation to scientific and technical progress under Directive 2002/95/EC: Final Report. With the assistance of Stéphanie Zangl, Rita Groß, Anna Weber, Oeko-Institut e. V. and Otmar Deubzer, Fraunhofer IZM. http://ec.europa.eu/environment/waste/weee/pdf/final_reportl_rohs1_en.pdf

26.1.2 Amount of Hexavalent Chromium Used under the Exemption

Dometic¹⁴⁷⁸ states that the average amount of CrVI used for a typical refrigerator model is around 2 grams.

Regarding the amount of substance entering the EU market annually through the application for which the exemption renewal is requested, Dometic estimates:

" approximately 200 kg per annum referring to units produced by Dometic."

This is understood to be relevant only for products that Dometic considers to fall under RoHS (i.e., used in lodging industry and private homes), which are part of its manufacture.

Dometics' total annual use of CrVI for its whole product range (also including products with a gas running heater and a high boiler temperature) is estimated at 700 kg/year.¹⁴⁷⁹

26.2 Description of Requested Exemption

According to the applicant¹⁴⁸⁰, sodium chromate (a hexavalent chromium compound) functions as a corrosion inhibitor in the carbon steel structure of the cooling unit in absorption refrigerators. The cooling solution consists of ammonia, water, sodium chromate and hydrogen gas, retained at a sufficient pressure to condense ammonia at the ambient temperature. To allow a long service life of the sealed cooling system, the sodium chromate in the cooling solution protects the steel pipes from interior corrosion that would arise in the presence of the corrosive ammonia.

Dometic¹⁴⁸¹ states that they have searched for alternatives to CrVI "*for decades*" and that their tests included solutions such as coatings, substrate materials and altering design parameters. Dometic¹⁴⁸² further explains that they have identified an alternative corrosion inhibitor, which has reached successful laboratory results:

" This inhibitor, named inhibitor #7, was found to be able to protect the carbon steel tubing from corrosion after 3 years of continuous circulation and it was consequently selected for further testing."

Dometic considers inhibitor #7 as a candidate to replace CrVI, with an acceptable expected life time, performance and safety level. However, some tasks need to be completed before inhibitor #7 can be used on a large scale.

¹⁴⁷⁸ Op. cit. Dometic (2015a)

¹⁴⁷⁹ Op. cit. Dometic (2015c)

¹⁴⁸⁰ Op. cit. Dometic (2015a)

¹⁴⁸¹ Op. cit. Dometic (2015c)

¹⁴⁸² Op. cit. Dometic (2015a)

26.3 Applicant's Justification for Exemption

According to Dometic, a renewal of the exemption for three years is needed in order to complete the following tasks that are needed to ensure a long service life of the absorption refrigerators: ¹⁴⁸³

- "Finalising and extension of field tests and increased testing of some specific models.
- Redesign of our cooling units to decrease the boiling temperature and minimising the risk for corrosion inside the tubes. This is an extensive work as we have close to 100 different models of cooling units in production.
- Design and installation of factory equipment for inhibitor #7. This important step includes also reliability testing of inhibitor #7 in combination with the new equipment."

In order to use sodium chromate in minibars Dometic has applied for an exemption under the RoHS directive for a period of 3 years, until 2019.¹⁴⁸⁴

Dometic considers the minibars to fall under RoHS and characterises them as products with low boiler temperatures (<180°C). It is understood from the information provided by Dometic that the heater in products with low boiler temperature is exclusively run on electricity.

According to Dometic¹⁴⁸⁵, "products with higher boiler temperatures are mostly (but not exclusively) included in the RV and medical box product groups. Coincidentally these products are used in a harsher environment than products with lower operating temperature. They are exposed to considerable variation in outside temperature, vibration and they are on discontinuously." It is understood that these applications run on other energy sources then electricity (e.g. gas) or are able to run on variable energy sources. According to Dometic, for products with higher boiler temperature, the whole cooling unit has to be redesigned.

The timeline for the substitution strategy for the different products specified by boiler temperature is depicted in Section 26.3.3.

The identity of the possible substitute is not revealed by Dometic. Dometic¹⁴⁸⁶ indicates that the alternative corrosion inhibitor "inhibitor #7" is a mixture containing an inorganic salt and stabilisers.

¹⁴⁸³ Op. cit. Dometic (2015a)

¹⁴⁸⁴ Op. cit. Dometic (2015c)

¹⁴⁸⁵ Op. cit. Dometic (2015c)

¹⁴⁸⁶ Op. cit. Dometic (2015c)

26.3.1 **Environmental Arguments**

Dometic¹⁴⁸⁷ states that a closed-loop system exists for the absorption refrigerators and the refrigerant:

"The products are at end-of-life recycled as other refrigerators in a step 1 process (reclaim of refrigerant) and step 2 (shredding and material separation). The total recycling rate is more than 95%."

According to Dometic,¹⁴⁸⁸ the disassembling of the absorption refrigerators is specified through a recycling manual¹⁴⁸⁹, which states that *"The cooling unit should be emptied by* an authorized recycling company".¹⁴⁹⁰ Absorption refrigerators in recreational vehicles have to be removed and handled separately before shredding the complete vehicle.¹⁴⁹¹

Dometic¹⁴⁹² explains that they have developed recycling equipment together with another company, Herco, to reclaim cooling media from absorption fridges.¹⁴⁹³ This equipment enables reclaiming a minimum of 95% of the refrigerant. Dometic¹⁴⁹⁴ states that the reclaimed refrigerant is to be treated as hazardous waste.

Dometic notes that at end-of-life, less CrVI is recovered then initially applied: In the formation of the very thin and tight corrosion protective layer of chromium oxide (Cr_2O_3) on the interior tube surface, CrVI is reduced to less toxic trivalent chromium (CrIII).¹⁴⁹⁵ If the layer is damaged, it will be replenished by the sodium dichromate available in the solution. Dometic¹⁴⁹⁶ estimates that "90% of Cr(VI) is reduced to Cr(III) in the first 2-3 years of operating time. At the end of the product lifetime it can therefore safely be assumed that, more than 75% of the Cr(VI) has been consumed."

¹⁴⁹¹ Global ISDS system for car recycling:

¹⁴⁸⁷ Op. cit. Dometic (2015a)

¹⁴⁸⁸ Dometic (2016a), Dometic (2016), Answers to 2nd round of Clarification Questions, submitted 13.01.2016.

¹⁴⁸⁹ http://www2.dometic.com/FileOrganizer/1-international/x-

environment/Environmental%20Documents/Recycling%20Manuals/English/Manual-Recycling-Hotel.pdf ¹⁴⁹⁰ For the authorization of such companies, Dometic states that "an important element in this authorization is the harmonized standards that have been developed under WEEE-Labex and are now transformed into EN-standards. EN 50574 (Collection, logistics & treatment requirements of end-of-life household appliances containing volatile fluorocarbons or volatile hydrocarbons) sets up detailed requirements for the end-of-life treatment of cooling appliances including absorption fridges."

http://civd.adm.in/fileadmin/civd/images/technik/Dismantling Manual CIVD for IDIS evo4-1.pdf ¹⁴⁹² Op. cit. Dometic (2016a)

 ¹⁴⁹³ <u>http://www.herco-gmbh.com/en/products/cooling-unit-recycling/ammonia-based-chillers/</u>
 ¹⁴⁹⁴ Op. cit. Dometic (2015a)

¹⁴⁹⁵ Op. cit. Dometic (2015c)

¹⁴⁹⁶ Op. cit. Dometic (2015c)

26.3.2 Socio-economic Impact of Substitution

Dometic¹⁴⁹⁷ states in its renewal request that the substitution will have an economic impact in light of the increase in direct production costs and the increase in overhead. In the context of the RoHS Directive, Dometic did not provide further detail; however, additional details are available in an application that Dometic submitted to ECHA in the application for authorisation under REACH for the use of sodium chromate as an anticorrosion agent.¹⁴⁹⁸

26.3.3 Road Map to Substitution

As mentioned above, Dometic plans to finalize the substitution within three years and therefore applies for a renewal of exemption 9 for this duration. Dometic¹⁴⁹⁹ states that this timeline only applies to those products that are – in the opinion of Dometic – within the scope of RoHS. Dometic considers the products that are used, for instance, in the lodging industry and in private homes to fall under the RoHS Directive.

For the whole product range, Dometic¹⁵⁰⁰ plans to phase out the existing inhibitor gradually depending on application: The first products that will be placed on the market in 2018 with the substitute (i.e. CrVI-free) will be products running with electrical heater in low boiler temperature applications (140-180°C), which are typical for a minibar. To complete substitution in such units, the cooling unit needs to be re-designed and a boiler temperature management system needs to be introduced. These changes require some development and testing planned to be completed by 2018. According to Dometic¹⁵⁰¹, the tasks already listed in bullet points under Section 26.3 have to be carried out in order to ensure reliable and safe products (field tests, redesign of cooling unit models, development of appropriate factory equipment).

The timeline for other products that Dometic considers to be outside the scope of RoHS can be found in Dometic's application for authorisation under REACH.¹⁵⁰² According to Dometic¹⁵⁰³, the products with higher boiler temperatures need more work before the new inhibitor can replace sodium chromate because the cooling units need to be

¹⁴⁹⁷ Op. cit. Dometic (2015a)

¹⁴⁹⁸ Dometic (2015c), Dometic (2015c), Dometic GmbH, Analysis of Alternatives and Socio-Economic Analysis, available under <u>http://echa.europa.eu/documents/10162/0783ee3a-7de9-45ec-a72a-c1689ee49e09</u>

Regarding the application for authorization, see also section 26.5.1.

¹⁴⁹⁹ Op. cit. Dometic (2015b): "Most of the products covered by the RoHS Directive are used in lodging industry and in private homes. Products for recreational vehicles (RV) and marine applications with absorption technology are most often specifically designed for that purpose and thus fall outside of the scope or RoHS. Several products for RV fall within the scope of the ELV-directive." See section 26.5.5 for the discussion on the scope of the exemption.

¹⁵⁰⁰ Op. cit. Dometic (2015b)

¹⁵⁰¹ Op. cit. Dometic (2015a)

¹⁵⁰² Op. cit. Dometic (2015c)

¹⁵⁰³ Op. cit. Dometic (2015c)

redesigned and new safety equipment has to be included. According to Dometic¹⁵⁰⁴, " products with higher boiler temperatures are mostly (but not exclusively) included in the RV and medical box product groups." Dometic¹⁵⁰⁵ explains that technical challenges arising for these product groups are also due to the more diverse operating conditions, e.g. varying ambient temperature, vibration and more frequent starts and stops.

Dometic¹⁵⁰⁶ makes a distinction within the products with higher boiler temperatures, and plans a gradual product launch from 2025 on. The complete phase out is envisaged by 2029 by Dometic.

26.4 Stakeholder Contributions

A single contribution was made during the stakeholder consultation regarding Ex. 5(b). The Test and Measurement Coalition (TMC)¹⁵⁰⁷ includes the seven leading companies in the sector representing roughly 60% of the global production of industrial test and measurement products. It is TMC's understanding that, according to the RoHS Directive, the exemptions listed in Annex III and Annex IV for which no expiry date has been specified, apply to sub-category 9 industrial with a validity period of 7 years, starting from 22 July 2017. This is also said to be explained in the RoHS FAQ.¹⁵⁰⁸ TMC, thus does not interpret the current exemption evaluation related to Exemption 9 to concern category 9 industrial equipment, for which the exemptions evaluated in the study "RoHS evaluations Pack 9" are understood to remain valid, and has thus have not provided exemption specific information.

After the consultation, other manufacturers of absorption refrigerants placing their products on the EU market were contacted in order to establish if some or all of these other manufacturers support the exemption request, or alternatively do not need the requested exemption renewal. Three manufacturers were urged to provide a statement. However, only Thetford actively provided information on their product range and substitution efforts.¹⁵⁰⁹

Thetford stated that their product portfolio differs from Dometic: It is limited to recreational vehicle absorption refrigerators and does not include minibar applications.¹⁵¹⁰ Thetford's absorption cooling units are manufactured in the USA. According to Thetford "All absorption refrigerators currently on the market use sodium

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_1_ae /General_Contribution_Test___Measurement_Coalition_package_9_exemptions_20151016.pdf

¹⁵⁰⁴ Op. cit. Dometic (2015c)

¹⁵⁰⁵ Op. cit. Dometic (2015b)

¹⁵⁰⁶ Op. cit. Dometic (2015c)

¹⁵⁰⁷ Test & Measurement Coalition (2015), Contribution by Test & Measurement Coalition, submitted 19 October 2015, available under

 ¹⁵⁰⁸ p. 26; http://ec.europa.eu/environment/waste/rohs_eee/pdf/faq.pdf
 ¹⁵⁰⁹ Thetford (2016a), Information provided by Thetford by Email, submitted 9 February 2016 and Thetford (2016b), Information provided by Thetford by Email, submitted 16 February 2016. ¹⁵¹⁰ <u>http://www.thetford-europe.com/product-category/refrigerators/</u>

chromate as a corrosion inhibitor as far as we are aware." Thetford already indicated during the last revision in 2009 that they were in the process of starting up a research project to investigate alternatives for the substitution of CrVI.

As for the scope of the exemption and its duration, Thetford¹⁵¹¹ is of the opinion that RoHS is as applicable to RV specific refrigerators as it is to generic household refrigerators. Thetford argues that any extension of exemption 9 should cover all relevant applications, and allow enough time to cover substitution or elimination for all these applications.

As for end-of-life, Thetford¹⁵¹² also claims to have a closed loop system operated by third party waste management service operators so that the refrigerant is removed and treated as hazardous waste.

26.5 Critical Review

26.5.1 **REACH Compliance - Relation to the REACH Regulation**

Appendix A.1.0 of this report lists various entries in the REACH Regulation annexes that restrict the use of CrVI in various articles and uses.

Sodium chromate (CAS 7775-11-3; EC 231-889-5) is included in REACH Annex XIV in light of its being identified as carcinogenic (category 1B), mutagenic (category 1B) and toxic for reproduction (category 1B).¹⁵¹³

Dometic GmbH and Dometic Hűtőgépgyártó és Kereskedelmi Zrt. submitted an application for authorisation under REACH for:

" the use of sodium chromate as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0.75% by weight (Cr6+) in the cooling solution".¹⁵¹⁴

Dometic GmbH in Germany and Dometic Hűtőgépgyártó és Kereskedelmi Zrt. in Hungary produce absorption refrigerators in Europe and would thus not be able to use sodium chromate without an authorisation after the sunset date of this substance specified in Annex XIV as 21 September 2017.

The application of authorisation covers the whole product range of absorption refrigerators produced in Europe: minibars, refrigerators for recreational vehicles and medical cold equipment. Dometic plans to phase out sodium chromate stepwise beginning with the electrically operated refrigerators. The phase out is planned to be

¹⁵¹¹ Op. cit. Thetford (2016b)

¹⁵¹² Op. cit. Thetford (2016b)

¹⁵¹³ Entry No 22in Annex XIV, sunset date 21/09/2017, latest application date 21/03/2016; <u>http://echa.europa.eu/addressing-chemicals-of-concern/authorisation/recommendation-for-inclusion-in-the-authorisation-list/authorisation-list/-/substance-rev/62/term</u>

¹⁵¹⁴ <u>http://echa.europa.eu/addressing-chemicals-of-concern/authorisation/applications-for-authorisation-previous-consultations/-/substance-rev/10106/term</u>

finalized in 2029. According to Dometic¹⁵¹⁵, absorption refrigerators that operate with gas and therefore have higher boiler temperatures need more technical development before the new inhibitor can replace sodium chromate (e.g. re-design of the cooling units, new safety equipment).

On 1 February 2016, ECHA's Risk Assessment Committee (RAC) and Socio-Economic Analysis Committee (SEAC) published its opinion recommending the requested authorisation to be granted with a review period scheduled within 12 years.¹⁵¹⁶ Assuming the authorisation is granted sodium chromate could still be manufactured and used in EU manufacture. In the opinion, the following condition for authorisation is noted:

"SEAC recommends that after the end of 2019 as described in the application, the authorisation of the use of sodium chromate is limited to the high boiler temperature product range only."¹⁵¹⁶

Assuming that the authorisation is approved, the renewal of the RoHS exemption would not be understood to weaken the protection afforded by REACH.

Entries 28, 29 and 30 of REACH Annex XVII also apply to sodium chromate. These entries require that specified substances "*Shall not be placed on the market, or used: as substances; as constituents of other substances; or in mixtures, for supply to the general public when the individual concentration in the substance or mixture*" is above a certain threshold.

Though one could argue that these entries do not restrict the presence of specified substances in articles, in which case they would not apply to the use of Dometic (since the refrigerator is an article), it is not completely clear how to interpret these restrictions. In the products at hand, sodium chromate is used as a constituent in a mixture which is enclosed within the cooling system. Though the consultants assume that the legislator mainly had in mind the provision to the public of substances and mixtures in containers that can be opened to allow use of the substance at hand, the derogations to these entries suggest otherwise. Paragraph 2 of this entry excludes some articles from this restriction, among others specifying in (c)(second item) that the restriction shall not apply to *"fuels sold in closed systems (e.g. liquid gas bottles)"*. In this sense the legislator would need to confirm whether the application at hand would be restricted through these entries or not.

Chromium VI also features in entry 47 REACH Annex XVII, where the use in cement is restricted. This is not considered to be relevant for absorption refrigerators.

¹⁵¹⁵ Op. cit. Dometic (2015c)

¹⁵¹⁶ ECHA RAC SEAC (2016), ECHA's Committee for Risk Assessment (RAC) and Committee for Socioeconomic Analysis (SEAC) (2016), Opinion on an Application for Authorisation for Sodium chromate use: The use of sodium chromate as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0.75% by weight (Cr6+) in the cooling solution, Consolidated version, 1 February 2016; http://echa.europa.eu/documents/10162/5a39678c-4e9a-42bc-878c-8997c74caeba

If the ECHA RAC SEAC recommendations to grant the authorisation for sodium chromate are to be followed, and assuming that Entries 28 through 30 do not apply, it can be considered that the requested RoHS exemption renewal would not weaken the environmental and health protection afforded by the REACH Regulation. In this case an exemption could therefore be granted if other criteria of Art. 5(1)(a) apply. The option that one of the restrictions addressed above and its implications on a possible exemption are discussed below in Section 26.5.6.

26.5.2 Scientific and Technical Practicability of Substitution

Dometic provides information according to which they plan to phase-out the use of CrVI from the entire product range, starting with the products understood to be the least technically challenging. It is understood that the first products applying the substitute shall be the absorption refrigerators with low boiler temperatures running exclusively with electricity. Dometic estimates the tasks to adapt these products to take three years. Dometic is confident that it shall meet this timeline:

"Our tests for the substitution alternative are still positive in relation to the main part of the products covered by RoHS (low boiler temperature applications – see below). We are currently making significant investments into production equipment in order to be able to meet the time line. In parallel there are still tests ongoing.

There is of course an existing risk that our following tests involving new production equipment and large quantities of products will fail. Should this happen we will have to renew the application to extend the exemption. However, we are very committed to the change when technically viable and given this we do not want to extend the exemption period longer than necessary."

It is understood that the substitution in products with higher boiler temperature still needs basic evaluation and technical development. In 2015, Dometic stated that the *"validation studies of inhibitor #7 function in higher boiler temperatures are ongoing."* The launch of first products applying the substitute in higher boiler temperature conditions is planned by Dometic for 2025. This time frame is longer than the maximum validity period possible for category 1 products under RoHS.

It further appears that other manufacturers are yet to achieve substitution in their absorption refrigerators and that they also need more time to complete the substitution tests and to achieve substitution in products to come on the market (e.g. Thetford).

To summarize, the consultants can follow that the development of substitutes has progressed, however also that implementation requires additional time in order to ensure the reliability of the substitute before it can come onto the market in absorption refrigerators.

26.5.3 Environmental Arguments

As already explored in Section 26.3.1, from information provided by Dometic, the consultants can follow that absorption refrigerators are recycled and that the cooling system with the cooling solution containing the CrVI is collected by recyclers with separate equipment.

This information suggests that possible environmental emissions related to End-of-Life (EoL) would be controlled, when the products are disposed of properly. Further information related to other environmental aspects was not provided.

26.5.4 Stakeholder Contributions

The contribution submitted by Test & Measurement Coalition raises a legal question as to the availability of the current exemption to category 9 equipment. Regardless of TMC's claims as to the availability of Annex III exemptions to sub-category 9 industrial for 7 years starting in 22.7.2017, in the case of exemption 9 the wording formulation limits its applicability to the anticorrosion agent applied in carbon steel cooling systems of absorption refrigerators. These products are understood to be a product, which as stated by the applicant fall under category 1 and not under category 9. Thus from a practical perspective, in the consultants' opinion, sub-category 9 industrial equipment would not benefit from the exemption directly.

26.5.5 The Scope of the Exemption

Dometic have requested the exemption for products that Dometic interprets to be in the scope of the RoHS Directive: These are mainly the low boiler temperature applications, where the heater is exclusively run on electricity. According to Dometic, ¹⁵¹⁷ "most of the products covered by the RoHS Directive are used in lodging industry and in private homes. Products for recreational vehicles (RV) and marine applications with absorption technology are most often specifically designed for that purpose and thus fall outside of the scope or RoHS. Several products for RV fall within the scope of the ELV-directive."

Generally speaking in article 2(4)(c)the RoHS Directive excludes "*equipment which is specifically designed and is to be installed, as part of another type of equipment that it is excluded or does not fall within the scope of this Directive..."*. The consultants assume that Dometic interprets the applicability of RoHS to its products on this basis. For example, where absorption refrigerators are specifically designed and are to be installed in caravans, this interpretation would mean that the equipment would be excluded from RoHS.

In this respect, Dometic¹⁵¹⁸ states: *"a) For the 2015 sales approximately 7 % of our products designed for recreational vehicles (RV) have been sold in after-market. Remaining 93 % have been sold in B2B direct to RV producers. It should however here be*

¹⁵¹⁷ Op. cit. Dometic (2015b)

¹⁵¹⁸ Op. cit. Dometic (2016)

highlighted that the major sales in after-market is not to private customers. We estimate that only less than 10 % of the sales in after-market is to private customers for product replacement and as do-it-yourself installations. The vast majority of the after-market sales is to professional companies providing installation. The absorption refrigerators for RV do have the option of running on several energy sources, and the installation of gas burner systems must only be carried out by certified personnel. Furthermore, the installation of a safe exhaust system is necessary to avoid flue gases into the living compartment. Due to this the installations made by private customers are limited. b) All Dometic absorption refrigerators designed for RV have electrical functions. One or two electrical heaters are assembled for running the refrigerator when electricity is available."

Thetford as another manufacturer of absorption refrigerators in RVs, however disagrees and claims that exemption 9 applies to RV specific refrigerators as it does to generic household refrigerators.

In this respect, the consultants believe that there may be room for interpretation regarding this issue. For example, in the case of units manufactured for caravans, it is understood that most units are originally installed as part of the vehicle before its sale, whereas in some cases units are purchased separately and possibly installed by the user. To begin with, this means that the same units are available both to manufacturers of caravan vehicles as well as on the open market (i.e. available to the public), where it is not straightforward to conclude that they would only be used for their intended purpose (i.e., to be installed in vehicles).

A more important aspect however seems to be the fate of such units at end-of-life, both in the case where the unit itself reaches EoL as well as in the case that the vehicle reaches EoL. In both of these cases it is understood that the unit would be dismantled from the vehicle and transferred to EoL treatment. When this is done by a vehicle dismantling facility, it is assumed that the unit is subsequently sent directly to a suitable recycler. In parallel, when the dismantling is done by the end-user, it is assumed that the unit would be seen as EEE and would be transferred to a Waste-EEE handling facility, subsequently also reaching a suitable recycler. Though the fate in both cases may be similar, the allocation of the unit at EoL to the EEE waste stream would suggest that the scope of articles falling under the RoHS Directive may be wider than suggested by Dometic. As it is assumed that in any case articles would be sent to treatment by a recycler of other refrigeration units (i.e., EEE recycler and not ELV recycler), the consultants conclude that the RoHS restrictions should apply as their original intention was to prevent and limit the presence of certain substances in the EEE waste stream. All the more so as the RoHS Directive restricts the use of additional substances in comparison with the ELV Directive. This logic is all the more applicable to units used for medical purposes, as long as they would not be excluded for example as large scale fixed installations (see Article 4(2)(e)). This is assumed as, medical devices fall under the scope of the RoHS Directive in any case. That said, it should be noted that only medical devices falling under the scope of the Medical Devices Directives (see RoHS Article 3(21-23)) would be considered as medical devices (Cat. 8) under RoHS, with others still falling

under Cat. 1. Even if refrigeration units would be covered by these Directives, the applicability of the RoHS restrictions would only be delayed in comparison with articles of category 1.

To conclude, the consultant interprets that a wider range of absorption refrigerators would be under the scope of the RoHS Directive and would need to comply with the substance restrictions, provided they have at least one electrical function and can thus be considered as EEE according to the Article 3(1 and 2) definitions.

26.5.6 Exemption Wording Formulation

Taking into account the considerations in the scope of the exemption as discussed above and the road map for substitution as provided by Dometic, a split of the exemption is proposed in light of the stepwise approach to substitution communicated by Dometic.

The consultants understand that CrVI shall be phased out within three years in the low boiler temperature applications that are run only on electrical supply in stable and favourable ambient conditions. An exemption for such applications would thus only require a three years duration as originally requested by the applicant. The proposed split of the exemption was discussed with the applicant to ensure a precise wording.

As a criterion to distinguish the different applications, it was discussed with the applicant if the boiling temperature could be used as e.g. done in Dometic's application for authorization under REACH because the internal corrosion increases significantly with the boiling temperature. However Dometic¹⁵¹⁹ stated that the boiling temperature varies significantly with the ambient conditions and the heat load of the cooling unit and that market control of boiling temperature would be difficult. The consultants proposed to describe the first split of the exemption via the energy source (*" absorption refrigerators designed to operate with electrical heater only"*). This is also understood to be a practicable solution from a market surveillance perspective.

Dometic¹⁵²⁰ then proposed a shorter duration for this split of the exemption for 2 ½ year until 1 January 2019. Though the consultants understand that Dometic assumes that this period shall suffice, possibly giving it a short termed advantage over competitors when the exemption expires, the consultants do not support this change. In the past review, industry requested to renew the exemption for additional 5 years, anticipating that substitution would be completed within this period. It is observed that the research and development of substitutes required additional time, currently leading to the request of an additional period. Dometic now request to shorten the exemption duration by 6 months. The consultants do not see this period as significant, whereas it shall provide a short termed margin for implementing substitutes, should the process be a bit longer than expected. The consultants propose to keep the original three years to ensure that substitution is reached by at least one manufacturer at this time so that a further

¹⁵¹⁹ Dometic (2016b), Dometic (2016b), email communication, submitted 12.02.2016

¹⁵²⁰ Dometic (2016c), Dometic (2016c), email communication, submitted 22.02.2016.

extension of this exemption in 2019 is not necessary. However if the EU COM sees this differently, the duration could be shortened, ending on 1 January 2019.

It has to be noted that this first split of the exemption would also be in line with the recommendation of ECHA RAC SEAC¹⁵²¹ where SEAC recommends the authorisation for the use of sodium chromate be limited to the high boiler temperature product range only after 2019.

As for the products with higher boiler temperatures, though the applicant has not requested a separate renewal for these articles, it is the opinion of the consultants that it is not conclusive if indeed all other articles are excluded from the scope of RoHS or not. From the additional information it is understood that substitution is underway in these articles, but expected to take a longer period. It would therefore be recommended to provide an exemption for a longer term for such applications, in order to reliably ensure substitution.

26.5.7 Conclusions

Article 5(1)(a) provides that an exemption can be justified if at least one of the following criteria is fulfilled:

- their elimination or substitution via design changes or materials and components which do not require any of the materials or substances listed in Annex II is scientifically or technically impracticable;
- the reliability of substitutes is not ensured;
- the total negative **environmental**, **health and consumer safety impacts** caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof.

From the available information it is observed that a substitute has become available as such. However, redesign and testing of absorption refrigerators is still in process and shall require at least a few more years. The implementation of the substitute is expected to differ for various applications of the product range of absorption refrigerators (i.e., those operated only with electricly powered heaters and those operated with other sources sources of energy), depending over all on the boiler temperature. The consultants appreciate the applicant's proposal of a shorter time frame of three years for low boiler temperature applications. However, as some products with higher boiler temperatures may fall under the scope of RoHS, a split of the exemption is proposed in order to differentiate the technical practicability of substitutes and to ensure its reliability in different applications, including where this is expected to take more than three years.

To conclude against the Article 5(1)(a) criteria:

¹⁵²¹ Op. cit. ECHA RAC SEAC (2016)

- Research conducted by Dometic did not result in reliable possibilities via design changes, coatings or materials; however an alternative anti-corrosion agent has been developed.
- Establishing tThe reliability of the identified substitute needs additional time to complete further testing, the re-design of components in different models and the development of factory equipment for absorption refrigerators with a heater running exclusively on electricity in low boiler temperature applications (140-180°C).

Substitution in other applications with a higher boiler temperature is expected to require a longer period. The time frame indicated by Dometic for these products to be launched on the market is 2025. However, exemptions for category 1 devices can only be granted for up to five years, at which time a revision of the further need of the exemption for these applications would allow evaluating whether inhibitor #7 has been successfully applied as a substitute or whether additional time would be needed.

26.6 Recommendation

It can be understood that a substitute has been discovered, however that additional time is needed to allow a phase-out of CrVI where used as anti-corrosion agent in absorption refrigerator units. This time shall allow necessary redesign of equipment and the completion of reliability testing and may differ for various units understood to be part of the product range. Assuming that the REACH authorisation requested by Dometic shall be granted and assuming that Entries 28-30 of REACH Annex XVII do not apply to sodium chromate when used as a cooling solution in the carbon steel structure of absorption refrigerator cooling units, the consultants conclude that the exemption is justified based on the Article 5(1)(a) criteria. In this case, the consultants recommend splitting the current exemption to differentiate between different products according to the time estimated to be required to complete substitution as follows:

Exemption 9	Duration*
Hexavalent chromium as an anticorrosion agent applied in carbon steel cooling systems of absorption refrigerators of applications:	
 (I) designed to operate with electrical heater only, with up to 0,75 % by weight in the cooling solution; (II) designed to operate with variable energy sources; (III) designed to operate with other than an electrical heater 	For Cat. 1: 21.7.2019 (three years)

Should the REACH authorisation requested by Dometic not be granted, the RoHS exemption could only be granted until the 21.9.2017 (i.e. the sunset date specified in REACH Annex XIV) so as not to weaken the protection afforded by the REACH Regulation. In this case the consultants would recommend maintaining the current formulation as both product groups are expected to still need the exemption until this date.

Should Entries 28-30 of REACH Annex XVII apply in this case, the renewal of an exemption would weaken the protection afforded by the REACH Regulation and thus could not be granted according to Article 5(1)(a).

The consultants' do not see a need to grant the exemption to Cat. 8 and Cat. 9 equipment, as the exemption formulation clearly limits the applicability to products falling under Cat. 1. Nonetheless, as for exemptions listed in Annex III, for which an expiration date is not specified, it is understood that from a legal point of view, they shall be valid for applications of Cat. 8 and Cat. 9 for up to 7 years. This validity period is understood to start from the dates specified in Article 4(3), from when these categories come into the scope of the Directive. Thus, if from a formal-legal point of view the original formulation of the exemption needs to remain valid for these categories for the specified duration, the following formulation would be recommended:

Exemption 9	Duration*
(III) Hexavalent chromium as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0,75 % by weight in the cooling solution	For Cat. 8 and 9: 21 July 2021;
	For Sub-Cat. 8 in-vitro: 21 July 2023;
	For Sub-Cat 9 industrial: 21 July 2024

26.7 References Exemption 9

Dometic (2015a), Original Application for Exemption Renewal Request, submitted 20.01.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_9 /9_150120_RoHS_V_Application_Form_Dometic.pdf

Dometic (2015b), Answers to Clarification Questions, submitted 13.08.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_9 /20150813_Ex_9_Dometic_replay_on_questions.pdf

- Dometic (2015c), Dometic GmbH, Analysis of Alternatives and Socio-Economic Analysis, available under <u>http://echa.europa.eu/documents/10162/0783ee3a-7de9-45ec-</u> <u>a72a-c1689ee49e09</u>
- Dometic (2016a), Answers to 2nd round of Clarification Questions, submitted 13.01.2016.

Dometic (2016b), Email communication, submitted 12.02.2016.

Dometic (2016c), Email communication, submitted 22.02.2016.

ECHA RAC SEAC (2016) ECHA's Committee for Risk Assessment (RAC) and Committee for Socio-economic Analysis (SEAC), Opinion on an Application for Authorisation for Sodium chromate use: The use of sodium chromate as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0.75% by weight (Cr6+) in the cooling solution, Consolidated version, 1 February 2016; http://echa.europa.eu/documents/10162/5a39678c-4e9a-42bc-878c-8997c74caeba Gensch, et al. (2009) Carl-Otto Gensch, Oeko-Institut e. V., et al., 20 February 2009, Adaptation to scientific and technical progress under Directive 2002/95/EC: Final Report. With the assistance of Stéphanie Zangl, Rita Groß, Anna Weber, Oeko-Institut e. V. and Otmar Deubzer, Fraunhofer IZM.

http://ec.europa.eu/environment/waste/weee/pdf/final_reportl_rohs1_en.pdf

- TMC (2015) Test & Measurement Coalition, Contribution by Test & Measurement Coalition, submitted 19 October 2015, available under <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_1</u> <u>a-</u> <u>e_/General_Contribution_Test__Measurement_Coalition_package_9_exemptions_2</u> 0151016.pdf
- Thetford (2016a), Information provided by Thetford by Email, submitted 9 February 2016
- Thetford (2016b), Information provided by Thetford by Email, submitted 16 February 2016

29.0 Exemption 21: "Lead and cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses"

Declaration

In the sections that precede the "Critical Review" the phrasings and wordings of stakeholders' explanations and arguments have been adopted from the documents provided by the stakeholders as far as required and reasonable in the context of the evaluation at hand. Formulations have been altered in cases where it was necessary to maintain the readability and comprehensibility of the text. These sections are based exclusively on information provided by applicants and stakeholders, unless otherwise stated.

Acronyms and Definitions

Cd	Cadmium
СМН	Ceramic Metal Halide
EEE	Electrical and Electronic Equipment
HGT	Hecker Glastechnik GmbH & Co KG
HID	High-intensity discharge [lamps]
HPS	High Pressure Sodium
IRL	Irlbacher Blickpunkt Glas GmbH (IRL)
LEU	Lighting Europe
PAR	Parabolic aluminized reflector
Pb	Lead
QMH	Quartz Metal Halide
TL(s)	Tubular lamps

29.1 Background

LightingEurope (LEU)¹⁶⁴⁶ has requested the renewal of Ex. 21 to ensure that lead and cadmium can further be used in printing inks applied as enamels to glass, such as borosilicate and soda lime glasses.

LEU¹⁶⁴⁷ explains that lead is used in printing inks applied to glass, and provides a durable product marking especially on the glass bulb of lamps. The durability is important to maintain the legibility of product markings throughout product-lifetime, as required by legislations and product safety standards.

Though lead-free ink solutions have been found, LEU claims that they cannot be effectively utilized in all situations with the required mark quality, and provide the following example (see Figure 29-1) to demonstrate the difference.

Figure 29-1: Examples of lead-containing and lead-free marking



PROLEMP -

Good marking with Pb containing ink Source LEU (2015a)

Marking with lead free ink in some applications

Thus, LEU requests the exemption be renewed with the following wording and with the maximum duration, and further specify that the exemption renewal is requested for Category 5 articles on which the inks are used (e.g. lamps):

"Lead and cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses"

LEU did not provide argumentation for the use of lead based inks in other applications aside from lamps, nor in relation to the need to renew the exemption for the use of Cd in

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_21/21_LE_RoHS_Exemption_Req_Final.pdf

¹⁶⁴⁶ LEU (2015a), LightingEurope, Request to renew Exemption 21 under the RoHS Directive 2011/65/EU Lead and cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses, submitted 15.1.2015, available under:

⁶⁴⁷ Op. cit. LEU (2015a)

inks used for the application of enamels on glasses. In a later communication LEU¹⁶⁴⁸ thus agreed that the exemption could be limited to the use of Pb in ink, and proposed the following exemption formulation:

"Lead in printing inks for the application of enamels on glasses"

LEU¹⁶⁴⁹ further explains that the exemption is relevant for use of lead in inks used on both mentioned types of glass, i.e. borosilicate and soda lime glass, and also on quartz glass.

29.1.1 Amount of Lead Used under the Exemption

LEU¹⁶⁵⁰ estimates the amount of lead placed on the EU market through lead based inks used for lamp marking in relation to some of the relevant lamp types:

- Double capped fluorescent lamps: the total amount of lead on the stamp in Tubular lamps (TLs) placed on the EU market is approximately 20 kg¹⁶⁵¹ lead per annum.
- The total amount of lead in high-intensity discharge (HID) lamps and parabolic aluminized reflector (PAR) lamps placed on the market per annum in Europe is less than 0.5 kg.
- For other lamps mentioned, LEU states that the amounts of Pb are very low.

LEU explains these estimations to be calculated by multiplying the volumes of lamps placed on the market with lead-containing marking with the estimated average amount of lead used per stamp (depending on mark size and text).¹⁶⁵²

29.2 Description of Requested Exemption

LEU¹⁶⁵³ explains that lead is used in inks, which are applied to lamp glass for marking purposes. Among others, such inks are used to mark fluorescent tubes, PAR lamps and HID lamps like High Pressure Sodium (HPS), Quartz Metal Halide (QMH) and Ceramic Metal Halide (CMH).

In a later communication LEU¹⁶⁵⁴ explains that the request concerns in general lamps where the lamp stamp is located on the glass material (e.g. tube or bulb) including: linear and (non) linear fluorescent lamps (e.g. T5, T8, T12), high pressure sodium lamps,

¹⁶⁴⁸ LEU (2015b), LightingEurope, Answers to 1st Questionnaire Exemption No. 21 (renewal request), submitted 10.8.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_21/20150810_Ex_21_ LightingEurope_Answers_to_1st_Clarification-Questions.pdf

¹⁶⁴⁹ Op. cit. LEU (2015b)

¹⁶⁵⁰ Op. cit. LEU (2015a)

¹⁶⁵¹ This value was stated as 2 kg in LEU (2015a) but later corrected in LEU (2015b) to 20 kg.

¹⁶⁵² Op. cit. LEU (2015b)

¹⁶⁵³ Op. cit. LEU (2015a)

¹⁶⁵⁴ Op. cit. LEU (2015b)

ceramic metal halide lamps, quartz metal halide lamps, PAR lamps, incandescent lamps for special purposes (exempted from 244/2009) and halogen lamps (low and mains voltage). It is elaborated that there is currently no expectation that such lamps are to be phased out in the coming years. Nonetheless, LEU¹⁶⁵⁵ has mentioned that the focus of the current lighting industry is on the further development of LED technology and that an extension of the exemption will have no negative effect on the efforts to further innovate in LED.

Lead is needed to make a mark on the soda lime glass that durably stays on the lamp throughout the lifetime of the lamp. Lead helps the marking ink to fuse into the glass surface. The ink has to adhere to the glass within a few seconds without being damaged in the course of other manufacturing processes. In the black ink, a so called lead-containing glass frit is used as adhesion compound to the glass. In the green (lead-free) ink an aluminium phosphate is used for the adhesion to the glass.

In a later communication, LEU adds that "Lead-containing ink is not only limited to the black colour inks, it is also used in silver/golden coloured stamps. The ink recipe is completely the same for the silver/golden stamp colours...The printing ink composition can be very much dependant on manufacturing and lamp marking process, hence not solely related to lamp stamp colour. Different lamp marking colours are also used to execute proper market communication and product positioning strategy by various manufacturers".¹⁶⁵⁷

Lead is one of the components in the low melting glass (enamel), which is in turn a component in the ink. This enamel has a very low softening point due to the presence of lead, which is needed to adhere the pigment particles in the ink to the bulb glass of the lamp, without affecting the lamp bulb glass itself, during the fixation process of the marking to the lamp bulb glass, which is carried out at elevated temperatures.¹⁶⁵⁸

LightingEurope¹⁶⁵⁹ is of the opinion that the question whether glass marked with pigment particles embedded in enamel is considered as homogeneous material is not resolved completely. Hence, since the marking cannot be removed by mechanical abrasive means LightingEurope considers the marked glass as homogenous material. This was the position of ELC some years ago when the exemption was extended from borosilicate glass to all type of (lamp) glasses. This exemption gave legal certainty to manufacturers, supply chain and authorities.

According to LEU¹⁶⁶⁰, the marking has several functions, during the entire life cycle:

¹⁶⁵⁵ Op. cit. LEU (2015a)

¹⁶⁵⁶ Op. cit. LEU (2015a)

¹⁶⁵⁷ LEU (2016a), LightingEurope, Answers to 2nd round of clarification questions, submitted per email on 29.1.2016

¹⁶⁵⁸ Op. cit. LEU (2015b)

¹⁶⁵⁹ Op. cit. LEU (2015b)

¹⁶⁶⁰ Op. cit. LEU (2015b)

- To identify the producer (a.o. brand and "Made in ...");
- To identify lamp type and wattage, which is relevant for safety, correct lamp replacement and recycling;
- CE, WEEE marking.

LEU then elaborates:

"Product identification is legally required for CE Marking according to the LVD Directive (2006/95/EC). A list of harmonized standards falling under this directive is published in OJEU as 2015/C 125/02. For instance, the marking requirement for linear fluorescent lamps is given in safety standard EN61195 in clause 2.2.1. Moreover, marking of lamps at the end of life is also required by the WEEE Directive (2002/96/EC)... marking of lamps must fulfil criteria set by standards and regulations, among others related to safety directive, WEEE and information essential for lamp identification must be visible during the entire service life. For example on straight fluorescent lamps, the lamp glass is the only place where this labelling on the product itself is possible, due to limited space and regulated size on marking on any other visible component such as lamp base (cap).

Product identification must be legible for the consumer or other stakeholders during the entire life cycle of the product (safety, replacement, recycling etc.). Intensive heat and light during lamp operations result in quality challenges for the marking of a lamp. Some luminaries state maximum wattage in order to avoid excessive heat. If a mark is not properly legible for the user, the user might place the wrong lamp into a luminaire with the consequence of a high safety risk. Maximum lamp temperatures may differ per lamp type and application. For example, clause 2.9.1 in EN61195 for linear fluorescent lamps states that maximum cap temperature rise can vary from 55 to 95K depending on the specific product type.

It also has to be considered that a lamp can be used for a certain period of time, exchanged against another lamp in an existing application but still not at end of life. If this lamp is used again, packaging and other product description are no longer available, hence general product designations are important to be present on the lamp." ¹⁶⁶¹

¹⁶⁶¹ Op. cit. LEU (2015a)

29.3 Applicant's Justification for Exemption

29.3.1 Possible Alternatives for Substituting RoHS Substances

LEU¹⁶⁶² claims that lead-free ink solutions (green ink using aluminium phosphate) have been found, but they cannot be effectively utilized in all situations with the required mark quality yet. Damaging of the marking (i.e. affecting legibility) can already appear during processing of the lamps. LEU provides examples of lamps marked with lead based and lead-free inks to demonstrate the difference in durability (see Figure 29-1). As it is explained that lamp marking is required by various legislations and standards, the phasing out of lead-based inks could hinder marking in some cases: *"some companies from LightingEurope cannot always apply the required stamp in all situations"*.

As for the possibility of using lead-free inks in all applications (e.g., green ink) in a later communication, LEU¹⁶⁶³ states that *" The usage of lead in ink is very much related to the manufacturing process, especially where in this process lamp marking is located [i.e. at what stage of manufacture the marking is applied – consultants comment]. When the marking is executed at the beginning of the production process, marking has to survive all further process steps, before the lamp leaves manufacturing line. In most lamp production lines the lead-free marking does not survive these next process steps between marking and fixation of the ink and the mark is not readable anymore. Due to that reason in T8/T12 lamps ... lead based inks are used. When lamp marking process is located at the end of production line (e.g. T5 manufacturing) and different printing technology is used (e.g. pad printing), opportunity to use lead-free black ink exists. Existing manufacturing lines cannot be easily switched from (older) printing method (at the beginning of the lamp). This is only possible with high investment costs for such machines. Complete new printing equipment has to be installed for T8 and T12 lamps."*

29.3.2 Possible Alternatives for Eliminating RoHS Substances

LEU¹⁶⁶⁴ explains that marking the glass with etching/engraving does not seem to be technically feasible due to cracks. Further alternatives of ink marking that would eliminate the need for using lead based inks were not mentioned.

29.3.3 Environmental Arguments

LEU¹⁶⁶⁵ explains that lamps are in the scope of EU Directives 2002/96/EC - WEEE and 2012/19/EU – WEEE Recast. All lamps need to be collected and recycled, regardless if they use lead-free or lead-based inks for the marking. Take back systems are installed in all EU Member States to facilitate the collection and the proper handling of lamps at end-of-life (further details are given in the exemption renewal application dossier, but

¹⁶⁶² Op. cit. LEU (2015b)

¹⁶⁶³ Op. cit. LEU (2016a)

¹⁶⁶⁴ Op. cit. LEU (2015b)

¹⁶⁶⁵ Op. cit. LEU (2015a)

are not detailed here as they concern lamps in general and do not provide specific details as to the fate of Pb from ink markings of lamps).

29.3.4 Socio-economic Impact of Substitution

LEU¹⁶⁶⁶ claims that substitution of lead based inks would result in socio-economic costs including an increase in fixed costs and possible social impacts within and external to the EU. After being asked to detail such possible costs, LEU¹⁶⁶⁷ elaborated that the impact on fixed costs is related to development needs and consequently possible changes to production equipment and processes. The social impact however is related to potential job losses if proper alternatives cannot be secured and the exemption (at the same time) is not granted.

29.4 Stakeholder Contributions

Three contributions were made to the stakeholder consultation.

The Test and Measurement Coalition (TMC)¹⁶⁶⁸ includes the seven leading companies in the sector representing roughly 60% of the global production of industrial test and measurement products. It is TMC's understanding that according to the RoHS Directive, the exemptions listed in Annex III and Annex IV for which no expiry date has been specified, apply to sub-category 9 industrial with a validity period of 7 years, starting from 22 July 2017. This is also said to be explained in the RoHS FAQ, p. 26 <u>http://ec.europa.eu/environment/waste/rohs_eee/pdf/faq.pdf</u>. TMC, thus does not interpret the current exemption evaluation related to package 9 to concern category 9 industrial equipment and has not provided exemption specific information.

Irlbacher Blickpunkt Glas GmbH (IRL)¹⁶⁶⁹ is a manufacturer of technical glasses, e.g. control panels, for various applications (white goods, lightning, laboratory, medicine, sanitary industry, and others). IRL explains that among the manufacturing processes applied, the application of lead- and cadmium-containing inks on glasses like borosilicate, soda lime glasses and others are sometimes involved. Subsequently a high-temperature process is applied for enamelling. Inks used by IRL for enamelling glass may contain both lead and cadmium and thus the stakeholder suggests not changing the current exemption wording formulation. Inks for enamelling glasses are explained to contain glass frits, high temperature stable pigments and additives like solvents.

¹⁶⁶⁶ Op. cit. LEU (2015a)

¹⁶⁶⁷ Op. cit. LEU (2015b)

¹⁶⁶⁸ TMC (2015), Test & Measurement Coalition, General comments related to RoHS exemption package 9, submitted 16.10.2015, available under

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_1_ae_/General_Contribution_Test___Measurement_Coalition_package_9_exemptions_20151016.pdf

¹⁶⁶⁹ IRL (2015a), Irlbacher Blickpunkt Glas GmbH, Reply to Consultation Questionnaire Exemption No. 21 (renewal request), submitted 7.10.2915, available under:

<u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_21/Reply_to_Consult_ation_Questionnaire_Exemption_No._21_online.pdf</u>
Whereas the latter will be removed¹⁶⁷⁰ during the enamelling process, glass frits and pigments will form a permanent connection with the glass, i.e. the substrate which was coated by the ink. Those inks may not only by used for marking lamps, but also for the decoration of (flat) glasses like soda-lime and borosilicate glasses (see Figure 29-2). In the latter case, inks will be applied on glasses for creating custom-built designs like logos or for the positioning of buttons, just to name a few examples. Glasses with lead- and cadmium-containing enamels are used in different fields of application, like household appliances, lighting equipment, medical devices, industrial instruments and others.



Figure 29-2: Example of decoration of borosilicate glass with black ink.

Source: IRL (2015a)

IRL¹⁶⁷¹ confirm that lead-free alternatives are available on the market, but explain that they have some disadvantages which exclude their application for the decoration of (flat) glasses. First of all, and most crucial, the adhesion on the glass will be drastically reduced when using lead-free inks (Figure 29-3). Beside this there are some reasons, like higher enamelling temperature or reduced opacity, which contradict a stable and environmentally friendly process control. The opacity of lead-free inks is also explained to be too low to allow a replacement of lead-containing inks.

 ¹⁶⁷⁰ This is assumed to mean that the solvents evaporate during the process of application – consultant's comment.
 ¹⁶⁷¹ Op. cit. IRL (2015a)

Figure 29-3: Comparison of lead-free (left) and lead-containing (right) ink. On the left side the ink shows a so called "chipping", i.e. peeling off from the substrate (borosilicate glass).



Source: (IRL (2015a)

IRL further explains that besides lead-containing glass frits, cadmium may be used in the pigment-component of inks. For the production of bright colourings, e.g. yellow, red or orange (see Figure 29-4) it is indispensable to use pigments with cadmium containing compounds. There are no alternatives available. Cadmium-free inks are not available for the production of bright colourings, thus cadmium-based pigments are essential. The stakeholder does not suppose the invention of cadmium-free equivalents in the future.

Figure 29-4: Enamels on borosilicate glass giving bright yellow (left) or orange (right) colourings



Source: (IRL (2015a)

IRL further contends that to the best of its knowledge, there are no ongoing research initiatives at present. In case of potential future research projects the adhesion as well as the opacity should be the major focus for the substitution of lead in inks. Lead-free inks could be used if significant improvement in adhesion and opacity can be obtained. Based on IRLs opinion cadmium cannot be removed from inks for enamelling glasses at present.

A second contribution was made by Hecker Glastechnik GmbH & Co KG (HGT)¹⁶⁷², explained to be a specialist for heat-resistant and safety glass. HGT is a make-to-order supplier for the industry. HGT is a manufacturer of glass for lighting applications and technical products (e.g. glass for lighting, medical technologies, engineering and household and bath appliances as well as glass for automation). HGT's contribution outlines the same aspects raised in the IRL contribution, and are thus not repeated here. In short, HGT also support the renewal of the exemption with its current formulation, allowing the use of both lead and cadmium in printing inks applied as enamels to glass.

29.5 Critical Review

29.5.1 **REACH Compliance - Relation to the REACH Regulation**

Appendix A.1.0 of this report lists various entries in the REACH Regulation annexes that restrict the use of lead and cadmium in various articles and uses.

Entry 23 of Annex XVII of REACH restricts the use of Cd in application. Paragraph 1 regards various materials that can be summarised as plastic materials, thus not relevant for this exemption which relates to the use of Cd in ink enamels used on glass. Use in metal plating, in brazing fillers and in metal parts (jewellery, beads) is also restricted in later paragraphs, but understood not to be relevant to the application at hand.

However, according to Paragraph 2 of Entry 23, Cd:

"2. Shall not be used in paints [3208] [3209].

For paints with a zinc content exceeding 10 % by weight of the paint, the concentration of cadmium (expressed as Cd metal) shall not be equal to or greater than 0,1 % by weight.

Painted articles shall not be placed on the market if the concentration of cadmium (expressed as Cd metal) is equal to or greater than 0,1 % by weight of the paint on the painted article."

This article is understood only to apply to paints with a zinc content above 10%. This is understood not to apply to the enamelling inks.

¹⁶⁷² HGT (2015a), Hecker Glastechnik GmbH & Co KG, Reply to Consultation Questionnaire Exemption No. 21 (renewal request), submitted 13.10.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_21/HGT_Reply_to_Co_nsultation_Questionnaire_Exemption_No__21.pdf

Entry 28 and entry 30 in Annex XVII of the REACH Regulation, stipulate that various cadmium compounds and lead compounds shall not be placed on the market, or used, as substances, constituents of other substances, or in mixtures for supply to the general public. In the consultants' understanding, the restriction for substances under Entry 28 and Entry 30 of Annex XVII does not apply to the use of cadmium and lead in this application. Cd and Pb used in inks applied to glasses, in the consultants' point of view is not a supply of cadmium or lead and its compounds as a substance, mixture or constituent of other mixtures to the general public. Cd and/or Pb are encapsulated in a vitreous enamel material which is part of an article and as such, entry 28 and entry 30 of Annex XVII of the REACH Regulation would not apply.

Entry 63 of REACH Annex XVII restricts the use of lead and its compounds in jewellery and also in "articles supplied to the general public, if the concentration of lead (expressed as metal) in those articles or accessible parts thereof is equal to or greater than 0.05 % by weight, and those articles or accessible parts thereof may, during normal or reasonably foreseeable conditions of use, be placed in the mouth by children". Though it is possible that some articles for which the current exemption is relevant may fall under this restriction, Paragraph 8(d) of Annex XVII excludes from the aforementioned restriction "(d) enamels, defined as vitrifiable mixtures resulting from the fusion, vitrification or sintering of mineral melted at a temperature of at least 500°C;" from the restriction. As the enamels used in the applications relevant for the exemption are understood to be fused to the glass article, this exclusion would be understood to apply, as long as the application process occurs at a temperature which is above 500°C. In parallel, the lead restriction within REACH Annex XVII entry 63 provides, under Paragraph 8(k), for an exclusion of articles in the scope of various Directives, among others specifying Directive 2011/65/EU (RoHS 2). Thus, it is understood that regardless of the enamelling temperature that this restriction would not apply, leaving the regulatory process entirely to RoHS. This aligns with a communication from the European Commission on the relationship between RoHS and REACH:

*"in those situations in which the RoHS restriction generally takes into account the protection of human health and the environment, at all stages, similarly to REACH restrictions, the latter should exclude EEE from their scope of application, indicating that the use of the substance in question in EEE is restricted by the RoHS Directive."*¹⁶⁷³

No other entries, relevant for the use of cadmium and lead in the requested exemption could be identified in Annex XIV and Annex XVII (status February 2016).

Based on the current status of Annexes XIV and XVII of the REACH Regulation, the requested exemption would not weaken the environmental and health protection

¹⁶⁷³ European Commission (date not specified) *REACH AND DIRECTIVE 2011/65/EU (RoHS): A COMMON UNDERSTANDING*,

http://ec.europa.eu/DocsRoom/documents/5804/attachments/1/translations/en/renditions/native

afforded by the REACH Regulation. Where this is the case, an exemption could be granted for the use of Cd and for the use of Pb if other criteria of Art. 5(1)(a) apply.

29.5.2 Scientific and Technical Practicability of Substitution

LightingEurope explains that lead is present in printing inks applied in lamp marking as enamels to borosilicate, soda lime glass, and also to guartz glass, specifying that its presence is relevant in inks of black, silver and gold colour. LEU admits that other inks exist, such as green coloured inks, which are lead-free and which can be applied in some cases, however elaborates that this depends on the stage of lamp production at which the marking is applied. It can be understood that when the marking is applied towards the end of the lamp production process, green inks (lead-free) are suitable, making the use of lead-based inks unnecessary. In contrast however, when the marking is applied at the beginning of the production process, the lamp parts are still to go through the various production stages, and thus the durability of lead-free inks does not suffice. Though LEU does not expect the production of lamps using the lead-based marking to be phased out in the coming years, changing the printing methods used in the processes and/or their location at the beginning or end of the process is explained not to be practical; existing manufacturing lines cannot be easily switched from (older) printing methods located at the beginning of the lamp production process, as this would require high investment costs for such machines.

Two manufacturers, of technical glasses (IRL) and of heat-resistant and safety glasses (HGT) further explain that the exemption is also needed for applying lead- and cadmiumcontaining inks on glasses like borosilicate, soda lime glasses and others. Subsequent to application, they explain that a high-temperature process is applied for enamelling. Inks are understood to be used for decorative applications and in some cases also for applying safety warnings. For Cd based inks it is explained that the main function of the Cd is in enabling the production of inks of specific hues, e.g., of different tones of red, orange and yellow. Lead in contrast is explained to be important as an ingredient of printing inks of different colours, as it allows reducing the enamelling temperature, and further increases the adhesion of inks to glass, the durability and the opacity of markings.

In relation to Pb, HGT¹⁶⁷⁴ provides further detail as to the properties provided by lead, for which Pb-free inks are not yet comparable:

- Adhesion depends on the thermal expansion coefficient (α) of the substrate = glass. Pb-free inks do not adhere to substrates with a very low α .
- The enamelling temperature of the ink to the glass is approximately 50K higher for Pb-free versions (the exact value depends on various parameters like colour/hue, the kind of substrate, etc.). For some substrates the

¹⁶⁷⁴ Op. cit. HGT (2016a)

enamelling temperature cannot be increased arbitrarily as defects would be introduced [i.e. to the glass - consultant's addition].

- **Durability** of ink markings according to HGT's experience, Pb-free versions are less stable towards hydrolytic weathering (hydrolytic class is reduced by approximately 1-2).
- Opacity of ink markings the values depend on various parameters, but in one comparison (black Pb-containing ink vs. Pb-free ink) printed by HGT, the absorbance decreases from ~3 to <2 (values at 600nm).

IRL¹⁶⁷⁵ have also provided information supporting these statements. IRL further explains that the addition of Pb simultaneously affects all of the properties mentioned above. In contrast to the use of Cd, the use of Pb in inks is not related to colour, but it is a constituent (in terms of lead oxide) in the glassy component of the ink and thus affects the properties mentioned above. Consequently, it is not only used in black hues, although this is the most used colour. Generally Pb can be added independently of colour to improve the properties mentioned above. The following detail is given in relation to the properties above:

- Adhesion "the range of α is typically ~0 K⁻¹ (so called glass ceramics, heat-resistant glass) to ~3 10⁻⁶ K⁻¹ (borosilicate glass) to ~9 10⁻⁶ K⁻¹ (sodalime glass).
- The enamelling temperature for Pb-free inks is ~700 °C; for Pb-containing inks it is ~650 °C¹⁶⁷⁶. Temperatures above 650°C would damage the substrate, i.e. various errors like surface failures up to complete breakdown of the substrate can occur.
- **Durability** is a basic requirement which permits the use of an ink for the decoration of glass. In this case durability means all aspects of resistance against attacks like mechanical (abrasion) or chemical (hydrolysis, acidic or basic corrosion, all kinds of solvents, etc.) attacks."
- In relation to opacity, "Absorbance (A) is defined as A = -log₁₀ T, where T is the transmission. A and T depend on wavelength, and 600 nm was meant as an example for a specific wavelength in the visible range of the electromagnetic spectrum. Absorbance is a measure for the opacity of an ink."

In this sense it can be understood that where Pb is used in inks applied to glass for applications other than lamps, that the various properties that it enables in the applied enamel are of importance. The stakeholders explain that Pb-free enamels do not provide comparable performance where these properties are concerned, while also requiring enamelling at higher temperatures.

¹⁶⁷⁵ Op. cit. IRL (2016a)

¹⁶⁷⁶ In the original document the sentence referred in both instances to Pb-free inks. This was corrected in an email communication from 16.02.2016 sent by IRL and HGT.

In parallel, however, it can be understood that a substitute has been developed that would at least provide sufficient performance for some applications. Schott AG have registered patent number DE 102014101140 A1¹⁶⁷⁷ for a glass flux-based coating substrate, detailing the glass flux material and the method for coating a glass or glass ceramic substrate. It is explained that for the preparation of heat resistant transparent layers (as well as other components, e.g., bottles, pipes, etc.), glasses with low thermal expansion coefficients are used, particularly borosilicate glasses and aluminosilicate glasses. In some applications, such glasses are coated, at least in part, for example with black or white ink, used to create frame forms or for applying text to the glass. The use of conventional glass flow-based coatings on glasses with a low thermal expansion coefficient is not optimal in light of thermal expansion coefficient differences. In such cases a thin layer can be applied, but this does not suffice for producing a sufficiently opaque layer. This is particularly true for lead-free glass-flow materials. Lead-free examples are detailed, which have various disadvantages (an enamelling temperature above 750°C, which is too high for borosilicate glasses; high thermal expansion coefficients, which do not allow thicker and thus also opaque layers; resulting coatings are not sufficiently durable with regard to chemical resistance). For this reason a leadfree alternative was developed with a low thermal expansion coefficient that achieves an opaque application with a high abrasion and chemical resistance (durability). It can also be understood that the softening temperature of the developed substitute is below 680°C, and can be as low as 650°C in some cases.

Schott AG were thus contacted and asked for information to allow a comparison of the development with lead-based inks. Schott AG^{1678} explains that the glass-flow coating has currently been developed with black, blue and white hues. The coating has been adapted for borofloat glasses, with an adhesion close to α =3.3. Schott AG states:

" Generally speaking we can say that we have (over)achieved same performance as enamels containing Pb, with regards to opacity, durability and adhesion, this was a clear target for the development of this enamel."

The development is understood to already be applied in products made available on the EU market (2 home appliance customers in Europe with >50k pieces per annum). Schott AG has not yet decided if to make the glass-flow coating available to third parties, however it does not foresee a problem to fulfil the potential demand for such inks in applications on glasses in the EU, should the exemption not be renewed.

http://google.com/patents/DE102014101140A1?cl=de&hl=de

¹⁶⁷⁷ Schott AG (2015), Schott AG, Registered Patent DE 102014101140 A1 for "Mit einer glasflussbasierten Beschichtung versehenes Substrat, Glasflussmaterial sowie Verfahren zur Beschichtung eines Glas- oder Glaskeramiksubstrats, published 30.7.2015, available under:

¹⁶⁷⁸ Schott AG (2016a), Schott AG, Answers to Questions Related to DE 102014101140 A1 in the Context of RoHS Annex III Exemption 21, submitted per email on 22.2.2016.

29.5.3 Environmental Arguments

LEU has provided some information related to the treatment of lamps with Pb-based markings at end of life. As this aspect is not understood to be directly related to the justification for the exemption, it is not discussed here.

29.5.4 Stakeholder Contributions

Three contributions were submitted to the stakeholder consultation. Contributions of HGT and IRL are discussed in the sections above as well as below.

The contribution submitted by TMC raises a legal question as to the availability of the current exemption to Category 9 equipment. The current exemption is not specific to a certain product or component, but only to the application of certain materials (enamels) on glass. Such applications may be used in Cat. 9 products (or in Cat. 8 products), and this is also raised by HGT and IRL who refer to medical and laboratory applications among others. In this sense the consultants interpret the contribution as support for the exemption, and note that a change in the wording formulation could affect articles falling under categories 8 and 9.

29.5.5 The Scope of the Exemption

LightingEurope originally applied for the exemption with a formulation as currently appears in Annex III of the RoHS Directive:

"Lead and cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses"

In contrast, their provided argumentation only concerns the application of Pb in printing inks applied as enamel to certain glasses, and thus after being asked, it was confirmed that where lamp marking was concerned, that the exemption could be limited to Pb. In parallel, LEU specified that in lamps, Pb-based printing inks could be applied in markings on borosilicate and soda lime glass, as well as on quartz glass, which was not originally included in the exemption formulation. Prior to the stakeholder consultation, they thus proposed an adjusted formulation, which is understood to cover applications for which LEU has requested the exemption renewal:

"Lead in printing inks for the application of enamels on glasses"

In this sense, where the exemption is needed for lamp marking applications, these changes could be taken into consideration in order to restrict a possible renewal of the exemption to lead and to certain glass types where it is needed for lamps.

In parallel, it is understood that the exemption is also needed for other types of applications. Since it can be understood that Cd is not needed for all printing ink colours and lead-free inks are available that could be applied in some cases, both HGT and IRL

were asked to further specify their information to allow a better understanding as to the scope of applications for which the exemption is needed.

In relation to Cd, HGT¹⁶⁷⁹ explains:

"Some worldwide introduced logos like the logo of AEG, 3M, Sparkasse, Vodafone, Shell, Coca Cola, and a lot of others are presented in colour tones which cannot be printed with ceramic colours without Cadmium-containing pigments. To be more specific, most of the RAL colour tones from 1000 to 3031 are affected. Besides those customer-specific needs there are some standards which define the use of RAL colours. For example DIN 4844-2 defines the colours for warning signs, where black triangles are to be printed on a yellow (RAL 1003 "Signalgelb") background. RAL 1003 can be printed by ceramic colours only by using Cadmium-containing inks".

To summarize, HGT claims that specific hues, for example RAL 3020 ("Verkehrsrot") or RAL 1003 ("Signalgelb") are not available in Cadmium-free versions. IRL have also specified these aspects in their response.¹⁶⁸⁰

When asked whether these applications types can be considered exhaustive, IRL¹⁶⁸¹ stated that "there are plenty of other applications, for example printing of flags, the usage of a specific hue for filter glasses (i.e. the colour printed is opaque for a certain range of electromagnetic radiation) or any imaginable custom-specific design (e.g. a customer asks for colour which is identical to an existing housing etc.). Consequently IRL cannot give an exhaustive list of applications."

HGT¹⁶⁸² and IRL¹⁶⁸³ further provide lists of hues (RAL specification) for which Cd-free alternatives are not available (See Appendix A.7.0). When requested to exhaustively detail standards specifying the use of Cd-based hues for certain applications (i.e. for safety related applications), HGT¹⁶⁸⁴ provided Table 29-1, explained to give a link between several colours and corresponding standards, which require that colour. HGT however notes that the list is not exhaustive and believes there are many more standards, which they are not aware of:

" Quite an important field of application, which is not regulated by any standard, is the realization of custom-specific designs: just to name two examples, RAL 2011 (dark-orange) is required for municipal vehicles and RAL 3003 (ruby red) for ambulance."

¹⁶⁷⁹ HGT (2016a), Hecker Glass Technik GmbH & Co KG, Answers to 1st round of clarification guestions, submitted per email 18.1.2016

¹⁶⁸⁰ IRL (2016a), Irlbacher Blickpunkt Glas GmbH, Answers to 1st round of clarification questions, submitted per email 18.1.2016 ¹⁶⁸¹ Op. cit. IRL (2016a)

¹⁶⁸² Op. cit. HGT (2016a)

¹⁶⁸³ Op. cit. IRL (2016a)

¹⁶⁸⁴ Op. cit. HGT (2016a)

RAL number	Standard in which	Stated purpose of	Further comments
(colour)	colour referred to	colour specification	
RAL 1003 (signal yellow), RAL 1004 (goldyellow), RAL 1007 (narcissusyellow)	DIN 4844-2	Colours for warning signs, where black triangles are to be printed on a yellow background.	Only available as Cd based ink
RAL 1003 (rape yellow), RAL 3000 (firered), RAL 3001 (signalred), RAL 2003 (pastel orange)	DIN 2403	Identification of tubes	Only available as Cd based ink
RAL 1023 (traffic yellow), RAL 2009 (trafficorange), RAL 3020 (traffic red)	DIN 6171	Surface colours for traffic signs and traffic installations	Only available as Cd based ink
RAL 2010 (signal orange), RAL 3001 (signalred) , RAL 3002 (chimney red)	DIN 5381	Identification colours	Only available as Cd based ink

Table 29-1: Use of Cd-based printing inks on glass specified in standards:

HGT and IRL¹⁶⁸⁵ provide more detail on such applications in a later communication. They explain that the use of the colours/ink is not limited to a specific application, and that they may be used inside and outside of the vehicle. The range of applications is said to be huge, with typical examples including printed signs on side windows (outside) or control panels/displays for electronic devices (inside).

In the consultants' opinion, not all of these additional applications would be covered by exemption 21. Uses for municipal vehicles and for ambulances are not understood to be covered by the exemption as these vehicles are not regulated under RoHS. If the statement regards equipment installed in these vehicles, some equipment may be RoHS regulated, assuming it is installed as a later addition to the vehicle and in this respect is also available to consumers on the market as equipment. If equipment is specifically designed for and installed only within these vehicles, it could be that it is excluded from the scope of RoHS through article 2(4)(c).¹⁶⁸⁶ In any case, the consultants cannot follow why equipment within these vehicles would need to have a specific colour in order to

¹⁶⁸⁵ HGT & IRL (2016a), Hecker Glass Technik GmbH & Co KG & Irlbacher Blickpunkt Glass GmbH, Reply to 3rd Round of Clarification Exemption No. 21 (renewal request), submitted per email 16.2.2016.

¹⁶⁸⁶ Article 2(4)(c) of Directive 2011/65/EU (RoHS 2): "Equipment which is specifically designed, and is to be installed, as part of another type of equipment that is excluded or does not fall within the scope of this Directive, which can fulfil its function only if it is part of that equipment, and which can be replaced only by the same specifically designed equipment."

fulfil their function. Furthermore, it is not clear how relevant "printing of flags" or custom-specific design would be, as it is assumed that not in all of these cases is the glass part of an EEE, whereas, only printing on glasses, which are part of an EEE are of concern to this request. Finally, for the use of "Cd and lead in filter glasses" more detail was requested. Cd in filter glasses is addressed by Ex. 13b, which was also recently subject to evaluation. In this sense, it is important to understand if and how the use of these substances in filter glasses to be used in EEE would differ from the scope of articles falling under Ex. 13b. HGT and IRL were thus asked to provide further detail and explained the following:

*"Such articles may fall under all categories of RoHS Annex I, depending on their application. Just to name a few examples filter glasses could be used in lighting applications and colour effect or food filter glasses."*¹⁶⁸⁷

"Various inks, among others Cd-based ones are used to coat glasses to lend the glass filtering functions. Through the coating, the glass will then allow certain wavelengths to pass through, while blocking others, depending on its colour or tone. The coatings usually appear semi-transparent to the eye, however where a light source is concerned shall only let certain wavelengths pass through, and are thus considered opaque to these wavelengths. In certain cases, coatings may appear opaque to the human eye, where they are used to block the visible light wavelength range and to only let non-visible wavelengths pass through. Coated filter glass is used as a component of lighting applications installed in displays and control panels of various equipment."¹⁶⁸⁸

*"From our point of view filter glasses covered by Ex. 13b throughout tinted glasses, i.e. Cd- or Pb-containing substances are added during the production of the glass itself. On the other hand "filter glasses" in our terminology are coated glasses (coating = ceramic ink, which may contain Cd or Pb)".*¹⁶⁸⁹

HGT and IRL later agreed that the term "colour printed glass" would be more appropriate for such glasses, in order to distinct them from filter glasses addressed under Ex. 13(b).¹⁶⁹⁰

In the consultants view, the justification for applications of this last group would be similar to the justifications given for Ex. 13b in relation to Cd in filter glasses. Cd is used as it allows a more accurate separation between the spectrum, which should pass through and that, which should be blocked. Alternative additives, as explained under the report for Ex. 13b, do not provide the same "sharp cut-off" accuracy. Use of organic pigments in various ways would also not be comparable as these are explained to fade

¹⁶⁸⁷ Op. cit. HGT & IRL (2016a)

¹⁶⁸⁸ HGT & IRL (2016b), Hecker Glass Technik & Irlbacher Blickpunkt Glass, Reply to 4th Round of Clarification Questions Regarding Exemption No. 21 (renewal request), submitted per email 17.2.2016 ¹⁶⁸⁹ Op. cit. HGT & IRL (2016a)

¹⁶⁹⁰ Op. cit. HGT & IRL (2016b)

with time and to be thermally unstable.¹⁶⁹¹ The consultants can thus follow that substitutes are not yet available for such applications and that an exemption would be justified, however that it would be important to address such applications more clearly in order for them to be distinguished from filter glasses covered under Ex. 13(b). In the consultants opinion it would be possible to address such applications both in respect to the application of printed colour on glass and in respect of the components in which such colours are used, thus limiting the scope to:

" the use of Cd in colour printed glass with filtering functions, used as a component in lighting applications installed in displays and control panels of EEE".

In theory, there are different approaches to applying filter applications and light conversion applications to lighting. For example, for down conversion with Cd-quantum dots, manufacturers mention three strategies: on-chip, on-edge, and on-surface.¹⁶⁹² In the on-chip strategy it can be assumed that the converting element may be sold with the LED (the chip) and would thus be understood as a lighting application, falling under Cat. 5. In on-surface however, a down-converting layer is assembled as a sheet in the display and it is assumed that this would be sold separately from the light source and would thus be a display component but not necessarily a lighting component. Applications of filter coating could thus also be relevant in some cases. The Cd-coating could thus in some cases by considered part of the lighting application, falling under Cat. 5, but in others it could be a separate component, related to the display or control panel and falling under a different category. Displays and control panels are therefore understood to be in use in different equipment and thus the exemption should be available to all categories. An exemption for this application could be left in Ex. 21, in light of the printing aspect, however it may be beneficial to add this application to Ex. 13b, as the justification is the same and substitutes that may be developed in the future could be of relevance for both types of filter applications.

In applications other than lamp markings, explained to be in scope, Pb is understood to enable a number of properties, some of which can reduce the energy consumption of

¹⁶⁹² Baron et al. (2014), Baron, Y.; Blepp, M.; Gensch, C.-O.; Deubzer, O.; in collaboration with Hogg, D.; Eunomia Research & Consulting Ltd. in cooperation with Oeko-Institut e.V. & Fraunhofer IZM; Assistance to the Commission on technological, socio-economic and cost-benefit assessment related to exemptions from the substance restrictions in electrical and electronic equipment (RoHS Directive)-Pack 4, Commissioned by: European Commission, DG Environment, Brussels pg. 49-50, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_IX/20140422_RoHS2_Evaluation_Ex_Req</u> <u>uests_2013-1-5_final.pdf</u>

¹⁶⁹¹ See Baron et al. (2016) Baron, Y.; Gensch, C.-O.; Moch, K. in collaboration with Gibbs, A. and Deubzer, O.; Eunomia Research and Consulting Ltd. in cooperation with Oeko-Institut e.V. & Fraunhofer IZM, Assistance to the Commission on technological, socio-economic and cost-benefit assessment related to exemptions from the substance restrictions in electrical and electronic equipment (RoHS Directive) – Pack 7, Commissioned by: EU Commission, DG Environment, Brussels, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/reports/20160129b RoHS Exemptions Pack7 F

inal_Report.pdf

manufacturing processes (enamelling temperature) and some of which influence the reliability of enamels created with such inks (adhesion, durability, opacity). In this respect Pb-based inks are understood to have advantages over <u>most</u> Pb-free inks, however, in parallel, it can be understood that a substitute has been developed which, based on the provided information, provides comparable performance when applied on borofloat glasses. The substitute is already applied on borofloat glasses used in products made available on the EU market, however, information was not available in sufficient detail to clarify that the substitute would provide the same reliability when applied on other types of glasses. It would also be of interest to understand if the substitute could be used in the lamp marking process to substitute lead-based inks when these are applied at the beginning of the manufacturing process.

29.5.6 Conclusions

Article 5(1)(a) provides that an exemption can be justified if at least one of the following criteria is fulfilled:

- their elimination or substitution via design changes or materials and components which do not require any of the materials or substances listed in Annex II is scientifically or technically impracticable;
- the reliability of substitutes is not ensured;
- the total negative **environmental**, **health and consumer safety impacts** caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof.

The information provided by LEU specifies that inks of various colours are used in lamp marking, some of which are actually lead-free. In other words, it can be understood that some alternatives have become available. The application of such inks is explained only to be possible when the marking stage is at the end of the lamp production process. In cases where the marking stage is at the beginning of the process, the reliability of the lamp marking does not suffice to ensure durability and legibility throughout the lamp life-time, mainly as the following manufacture stages may damage the marking.

Though the consultants can follow that the reliability of Pb-based inks (black, silver, gold) may be higher than the reliability of Pb-free inks (green), it can also be understood that this added reliability is only needed to avoid damage during the manufacturing stages. This is confirmed as LEU admits that in cases where the marking is applied at the end, the green ink, which is lead free, can be used.

LEU specifies that:

"Existing manufacturing lines cannot be easily switched from (older) printing method (at the beginning of the lamp). This is only possible with high investment costs for such machines. Complete new printing equipment has to be installed for T8 and T12 lamps".

In this sense it is understood that the reason for not switching to printing methods, that would allow the use of lead-free inks, is mainly an economical one. Article 5(1)(a) specifies that socio-economic aspects can be taken into consideration. However, as none

of the three primary criteria are fulfilled, the costs of substitution alone do not suffice to justify an exemption.

In relation to the use of Cd in printing inks used as enamels on glass, the consultants understand that Cd is used in printing inks to achieve certain hues of the enamel in various application areas. It can be followed that safety aspects and warning aspects may be required to be communicated with the use of certain hues, which are considered to increase visibility. This is assumed to be the reason why various standards, that regulate the safety of certain applications, specify certain colours for such purposes. It can also be followed that Cd is used for printing on glasses to create filtering functions, as substitutes for Cd in such applications would not provide comparable filtering accuracy or would be less reliable. Thus, where certain hues cannot be manufactured with Cd-free inks, the exemption could be renewed for all relevant applications. If this aspect however is not understood to be relevant as a technical aspect related to the availability of substitution, the EU Commission could limit the applicability of the exemption to Cd-based printing inks, where used to comply with standards and norms requiring the use of specific hues for safety applications and where used as a coating to produce filtering functions.

Where Pb inks are used on applications other than glass of lamps, it can be followed that Pb is necessary to provide various qualities of the marking. The presence of Pb allows reducing the enamelling temperature, which in turn would mean that less energy is consumed for this process in comparison with Pb-free leads where the enamelling temperature is higher. Pb also affects the durability and the opacity of the marking, as well as its adhesion to the glass. Though information available indeed supports that most Pb-free alternatives would not be comparable, a substitute is understood to have become available that can be applied on borofloat glasses and that provides comparable reliability. Though this alternative may be sufficient to allow substitution of all Pb-based inks used for enamel applications (i.e. in the full range of glass coating applications), the consultants can follow that some time would be needed to allow establishing that the alternative would be sufficiently reliable in [applications] other than borofloat glasses. A short termed exemption would thus be recommended for Pb-based inks used on other than borofloat glasses to allow establishing that the substitute is sufficiently reliable.

In the case of Cd-based inks, since information relating to the development of possible alternatives is currently not available, it can be followed that the exemption may be needed for at least 5 years, however as the applicant and the participating stakeholders did not provide any information to suggest that they are involved in research into substitutes, it could also be considered to provide the exemption for a shorter duration so as to create an incentive for stakeholders to develop a strategy for research and development of substitutes to allow substitution in the future.

29.6 Recommendation

As explained above, although lead-free substitutes exist for lamp markings, it can be understood that their application on lamp glass needs to be at the end of the lamp production process. In other words, when applied at the end of the process, substitutes exist and are understood to be reliable. Though implementing equipment changes to production lines may require significant investments, this is not understood to fulfil one of the three primary criteria for justifying an exemption. The consultants would thus recommend revoking this exemption. As the lighting industry is undergoing a transformation (from conventional technologies to LED) and as some lamp types can be expected to be phased-out within the next few years, the Commission may decide to renew the exemption despite the lacking technical justification, so as to avoid such costs for technologies approaching phase-out.

It can also be understood that substitutes for Pb in printing inks for the application of enamels on other than lamp glass applications are available in some cases, however that their reliability must be established for other than borofloat glasses. In their patent, Schott AG detail that borosilicate glasses include Borofloat33[°], Borofloat40[°], Fiolax[°], Duran[°] oder Pyrex. Characteristic of borosilicate glasses is their significant share of silica (SiO₂) and boric acid (B₂O₃ > 8%) as glass constituents. The consultants' understand the various glass types to be trademark names and is of the opinion that the substitute would thus be applicable to all borosilicate glass types.

As for Cd in printing inks for the application of enamels on glasses, these are understood not to be available for all hues of red, orange and yellow tones. Such tones are particularly necessary to comply with standards where colours are specified in relation to safety aspects. It can also be understood that some customers specify a certain hue in custom products, for example where a logo is printed on glass or where a glass element is to correspond to colours of other elements to be adjacent to it in use. Furthermore, there are no comparable substitutes for Cd inks used in colour printed glass applied to obtain filtering functions, when these are used as a component in lighting applications installed in displays and control panels of EEE.

The justification for the exemption where Cd is used as an ink to provide certain hues and colours is that alternatives do not provide sufficient colour compatibility. If this property can be judged as indispensable, then Ex. 21 could be renewed for Cd-based inks in all applications. If this is not a valid justification, it would be recommended to restrict the exemption for Cd in enamels used for printing of safety warnings and signs, as prescribed in various harmonised standards and norms which are valid in the EU. It would also be recommended to renew the exemption for "the use of Cd in colour printed glass with filtering functions, used as a component in lighting applications installed in displays and control panels of EEE". However, it may be beneficial to add this as a further item to Ex. 13b, which is closely related to this application in terms of the applicability of substitutes.

The following exemptions could thus be granted / renewed:

Exemption n. 21	Duration*	Comments			
 Cd when used in colour printed glass to provide filtering functions, used as a component in lighting applications installed in displays and control panels of EEE 	For Cat. 1-7 and 10: 21 July 2021	The EU Commission should consider if it would not be more beneficial to add this entry to Ex. 13b.			
 II. Alternative A: Cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses, when used to comply with harmonised standards specifying the use of particular hues for safety applications. Alternative B: Cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses, excluding Cd used in colour printed glass to provide filtering functions. 	For Cat. 1-7 and 10: 21 July 2021	The EU Commission could consider providing a shorter validity period so as to promote the supply chain to develop a strategy for research and development of alternatives for Cd-based inks.			
III. Lead in printing inks for the application of enamels on other than borosilicate glasses.	For Cat. 1-4, 6,7 and 10: 21 July 2019	The recommended period should suffice to establish the reliability of Pb-free substitutes in other than borosilicate glasses.			
<i>IV. Lead and cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses</i>	For Cat. 8 and Cat. 9: 21 July 2021 For Sub-Cat. 8 in- vitro: 21 July 2023 For Sub-Cat. 9 industrial: 21 July 2024	As it can be understood that the exemption duration may vary for various categories on the basis of Article 5(2), expiration dates have been specified here on the basis of the validity periods specified in Article 5(2) for categories, which are newly in scope.			

29.7 References Exemption 21

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- Baron et al. (2016) Baron, Y.; Gensch, C.-O.; Moch, K. in collaboration with Gibbs, A. and Deubzer, O.; Eunomia Research and Consulting Ltd. in cooperation with Oeko-Institut e.V. & Fraunhofer IZM, Assistance to the Commission on technological, socio-economic and cost-benefit assessment related to exemptions from the substance restrictions in electrical and electronic equipment (RoHS Directive) Pack 7, Commissioned by: EU Commission, DG Environment, Brussels, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/reports/20160129b_RoHS_Exemptions_Pack7_Final_Report.pdf

- HGT (2015a) Hecker Glastechnik GmbH & Co KG, Reply to Consultation Questionnaire Exemption No. 21 (renewal request), submitted 13.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_2</u> <u>1/HGT_Reply_to_Consultation_Questionnaire_Exemption_No__21.pdf</u>
- HGT (2016a) Hecker Glass Technik GmbH & Co KG, Answers to 1st round of clarification questions, submitted per email 18.1.2016
- IRL (2015a) Irlbacher Blickpunkt Glas GmbH, Reply to Consultation Questionnaire Exemption No. 21 (renewal request), submitted 7.10.2915, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_2</u> <u>1/Reply_to_Consultation_Questionnaire_Exemption_No._21_online.pdf</u>
- IRL (2016a) Irlbacher Blickpunkt Glas GmbH, Answers to 1st round of clarification questions, submitted per email 18.1.2016
- HGT & IRL (2016a) Hecker Glass Technik GmbH & Co KG & Irlbacher Blickpunkt Glass GmbH, Reply to 3rd Round of Clarification Exemption No. 21 (renewal request), submitted per email 16.2.2016
- HGT & IRL (2016b) Hecker Glass Technik GmbH & Co KG & Irlbacher Blickpunkt Glass GmbH, Reply to 4th Round of Clarification Questions Regarding Exemption No. 21 (renewal request), submitted per email 17.2.2016
- LEU (2015a) LightingEurope, Request to renew Exemption 21 under the RoHS Directive 2011/65/EU Lead and cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses, submitted 15.1.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/</u> RoHS_Pack_9/Exemption_21/21_LE_RoHS_Exemption_Req_Final.pdf
- LEU (2015b) LightingEurope, Answers to 1st Questionnaire Exemption No. 21 (renewal request), submitted 10.8.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_2</u> <u>1/20150810_Ex_21_LightingEurope_Answers_to_1st_Clarification-Questions.pdf</u>
- LEU (2016a) LightingEurope, Answers to 2nd round of clarification questions, submitted per email on 29.1.2016
- Schott AG (2015) Schott AG, Registered Patent DE 102014101140 A1 for "Mit einer glasflussbasierten Beschichtung versehenes Substrat, Glasflussmaterial sowie Verfahren zur Beschichtung eines Glas- oder Glaskeramiksubstrats, published 30.7.2015, avail. under http://google.com/patents/DE102014101140A1?cl=de&hl=de
- Schott AG (2016a) Schott AG, Answers to Questions Related to DE 102014101140 A1 in the Context of RoHS Annex III Exemption 21, submitted per email on 22.2.2016.
- TMC (2015) Test & Measurement Coalition, General comments related to RoHS exemption package 9, submitted 16.10.2015, available under <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_1</u> <u>a-e_/General_Contribution_Test__Measurement_Coalition_package_9</u> <u>exemptions_20151016.pdf</u>

31.0 Exemption 29: "Lead bound in crystal glass as defined in Annex I (Categories 1, 2, 3 and 4) of Council Directive 69/493/EEC (1)"

Declaration

In the sections that precede the "Critical Review" the phrasings and wordings of stakeholders' explanations and arguments have been adopted from the documents provided by the stakeholders as far as required and reasonable in the context of the evaluation at hand. Formulations have been altered in cases where it was necessary to maintain the readability and comprehensibility of the text. These sections are based exclusively on information provided by applicants and stakeholders, unless otherwise stated.

Acronyms and Definitions

EDG	European Domestic Glass
EEE	Electrical and Electronic Equipment
HCI	Hydrochloric acid
HF	Hydrofluoric acid
H_2SO_4	Sulfuric acid
LCG	Lead crystal glass
LEU	LightingEurope
Pb	Lead
UVCB	Substance of Unknown or Variable Composition, complex reaction products or Biological materials

31.1 Background

European Domestic Glass (EDG) and LightingEurope (LEU)¹⁷⁴⁷ have submitted a joint request for the renewal of exemption 29 of Annex III of the RoHS Directive to allow the use of lead in the manufacture of lead crystal glass to be applied in EEE.

Crystal is a substance characterized by a continuous and essentially non-crystalline or vitreous inorganic macromolecular structure, which is highly insoluble and inert. Obtained by a mineralogical process, resulting in a chemical network (matrix), crystal constituents are closely linked together and are in a specific chemical environment, different from the initial state of the raw materials.¹⁷⁴⁸

It is explained by the applicants¹⁷⁴⁹ that lead oxides (PbO or Pb₃O₄), are used as an intermediate for the chemical synthesis of Lead Crystal Glass (LCG). LCG is used in EEE applications because their unique combinations of processing and optical/decorative properties and characteristics allow the manufacture of EEE articles which could not be produced otherwise. Substitutes are said to have been sought over the latest two decades without success. The performance of alternative materials is worse and does not allow the production of articles with comparable properties, notably because of the insufficient workability time made possible by the lead oxide component. Various articles are named as types of EEE in which LCG is used (see Figure 31-1 for examples):

- Fixed/portable luminaires;
- Lamps;
- Electrified mirrors;
- Horology (clocks, watches etc.);
- Display cases;
- Digital photo frames;
- Tablet and smart phone docking stations;
- Furniture and home décor items (carrousel, tables etc.);
- Building materials (illuminated bricks).

Thus EDG & LEU request the renewal of the exemption with the following wording:

"Lead bound in crystal glass as defined in Directive 69/493/EEC"

¹⁷⁴⁷ EDG & LEU (2015a), European Domestic Glass and LightingEurope, Original Dossier Requesting the Extension of Exemption 29 in Annex III of Directive 2011/65/EU, submitted by the European Domestic Glass Association and by LightingEurope on 16.1.2015 to the EU COM, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_29/29_EDG_LE_RoHS</u> Exemption_Reg_final.pdf

¹⁷⁴⁸ EDG & LEU (2015b), European Domestic Glass and LightingEurope, Answers to 1st Clarification Questions regarding Exemption 29 in Annex III of Directive 2011/65/EU, submitted on 14.08.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_29/20150814_Ex_29_ EDG_LEU_1st_round_of_Clarification-Answers_final-Public.pdf

¹⁷⁴⁹ Op. cit. EDG and LEU (2015a)

The exemption has been requested for a period of 10 years. In this respect the applicants have specified that the exemption is requested for articles of categories 3 (IT and telecommunications equipment), 4 (consumer equipment), 5(lighting equipment) and 11(other EEE not covered by any of the categories above). Since Article 5(2) of the RoHS Directive limits the maximum duration of the validity of an exemption to 5 years in the case of EEE falling under Cat. 1-7, 10 and 11, the consultants interpret this to mean that the applicant requests the maximum applicable duration.

Figure 31-1: Example EEE in which lead crystal glass is used



Lighting applications (luminaires, chandelieres)



Electrified mirrors



Horology



Building materials - illuminated bricks



Display cases



Digital photo frames

Tablet and smart phone docking stations



Furniture and home décor items

Source: EDG & LEU (2015a, 2015b)

31.2 Amount of Lead Used under the Exemption

EDG & LEU¹⁷⁵⁰ explain that the Crystal Glass Directive 69/493/EEC¹⁷⁵¹ defines crystal alass into four categories along three criteria, among them its composition expressed notably as lead oxide up to over 30% by weight. Under the REACH Regulation, glass is considered as a UVCB substance (substance of Unknown or Variable Composition, complex reaction products or Biological materials). It is not a preparation and does not contain lead metal nor lead compounds as such. EDG and LEU explain that 130 tonnes¹⁷⁵² of EEE using LCG are placed on the EU market per annum. From the combined declarations of members of EDG who are LCG manufacturers, representing 80% of the EU market share, it can be understood that 40 tons/annum of Pb₃O₄ and PbO are used as an intermediate for the manufacture of LCG applied to EEE applications manufactured for the EU market. Thus 40 tons/annum of Pb₃O₄ and PbO are used to manufacture 104 tonnes of lead crystal electric/electronic articles, representing 80% of the EU market share. On this basis, it is estimated that for the total EU market, 130 tonnes are manufactured, of which 50 tons/annum of Pb₃O₄ and PbO would be used for manufacture.¹⁷⁵³ The Pb comprised in 50 tonnes of Pb₃O₄ and PbO is estimated to amount to 46 tons.¹⁷⁵⁴

31.3 Description of Requested Exemption

According to EDG & LEU¹⁷⁵⁵ lead oxides (PbO or Pb₃O₄), are used as an intermediate for the chemical synthesis of Lead Crystal Glass (LCG), as required by Council Directive 15 December 1969 on the approximation of the laws of the Member States relating to crystal glass (69/493/EEC). The amount of lead in the LCG has to be at a minimum of 24% expressed as PbO for the glass to be called "lead crystal" and above 30% for it to be called "full lead crystal". EDG & LEU stress that it does not mean that there is PbO nor Pb as such in the articles. It is simply a convenient way to express the result of an elementary composition analysis. It is further explained that under REACH Regulation¹⁷⁵⁶, Crystal Glass is itself a substance of unknown or variable composition,

¹⁷⁵⁰ Op. cit. EDG & LEU (2015a)

¹⁷⁵¹ COUNCIL DIRECTIVE of 15 December 1969 on the approximation of the laws of the Member States relating to crystal glass (69/493/EEC), (OJ L 326, 29.12.1969, p.36), available under: <u>http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:01969L0493-20070101</u>

¹⁷⁵² In the application document, both tons and tonnes are referred to. A Uk ton represents 1016 kg and an American one 907 kg, whereas a tonne represents 1000 kg. The consultants assume that the inconsistency is a typo and that tonnes, representing 1000 kg are meant, as this would be consistent with the explained calculation.

¹⁷⁵³ It is further noted that the former submission (exemption renewal request from 2008) indicated 145 tonnes/year, most probably because there was a confusion between lead crystal glass EEE applications and Pb oxide components.

¹⁷⁵⁴ Op. cit. EDG & LEU (2015a)

¹⁷⁵⁵ Op. cit. EDG & LEU (2015a)

¹⁷⁵⁶ Cited as REACH Regulation, Annex V and Guidance for Annex V, Entry 11, pp.38-39

which by convention is expressed as oxides of the constituent elements (SiO₂, Na₂O, K₂O, PbO, etc.). The addition of lead oxide enables:

- The production of exceptional articles otherwise impossible to obtain, through the:
 - increased working time with the glass, via excellent thermal and viscosity properties (melting and forming);
 - o unique optical properties needed for:
 - High refractive index nd > 1.56 (responsible for brilliance);
 - High dispersion nf nc > 0.01, preferably 0.013 (responsible for the refraction and reflection performance);
 - High light transmission (L > 98; -0.5 < a < 0; -0.5 < b < 0.5 (100 mm thickness immersion, light C, 2°, CIELAB);</p>
 - S No grey, but sharp colour transition;
 - o unique mechanical (cutting and polishing) process possibility;
 - o unique refinement (sustainable surface) process possibility;
 - o decorative aspects.
- A better energy efficiency. Measures demonstrate that from a same source (LED), the light flow transmitted through a crystal item is bigger by a factor of at least 10%, compared to the light flow transmitted by the same item in flint glass. The energy efficiency (lumen/watt) of crystal is therefore much better than in flint glass. In certain cases, the ranking Index of energy efficiency (IEE) of an electric lighting device can jump to category A (with crystal) from category B (with flint glass). In other words, less energy is required for lighting.

On this basis, EDG & LEU¹⁷⁵⁷ conclude the crystal glass is a component of high quality lighting and decoration applications (see Section 31.1), and is used for the very production of these articles otherwise impossible to manufacture, for enhancing light distribution or transparency thereof and for enabling specific decoration (shape and finishing).

In a later communication¹⁷⁵⁸ it is elaborated that in the hot process, the use of lead for the synthesis of crystal increases the working range. It reduces the viscosity of the melt for the same temperature, rendering it more fluid than ordinary glass. The viscosity of glass varies radically with temperature. This results in a few practical developments:

 Lead glass may be worked at a lower temperature, making possible the shaping of sophisticated items. Design is therefore determined by the cooling time: complex forms are not possible to produce in a glass (without lead) with a short working range – see Figure 31-2 representing viscosity as function of temperature for several types of glass. Simply stated, the working range of

¹⁷⁵⁷ Op. cit. EDG and LEU (2015a)

¹⁷⁵⁸ Op. cit. EDG and LEU (2015b)

glass is that range of temperatures that corresponds to the point where glass just begins to soften up to the point where glass is too soft to control. The ASTM and the American Ceramics Society committees on glass definitions summarize the definition now widely used in today's glass industries¹⁷⁵⁹: WORKING RANGE: "The range of temperatures in which glass is formed into ware in a specific process. For comparison purposes, when no specific process is considered, the working range of glass is assumed to correspond to a viscosity range from the working point to the softening point. (4 to 7.6 Log10 Poise)". A LONG glass will have a significantly longer temperature range from the working point to the softening point to the soften glass. Since glass blowers hand work (or hand process) glasses in this range they are able to readily distinguish a long glass from a short glass.

- The working range also has a direct impact on manufacturing cost due to reheating requirements (additional energy consumption, timing and defective items).
- Properties of the crystal are also key-factors for tools design; therefore any change in the properties may lead to major change requirements for the associated tools.



Figure 31-2: Viscosity as a function of temperature for several glass types

¹⁷⁵⁹ EDG and LEU (2015b) refers to pp. 677-680 in The Handbook of Glass Manufacture by Tooley and pp. 72-74 in Technical Glasses by Volf

31.4 Applicant's Justification for Exemption

EDG & LEU¹⁷⁶⁰ provide more detail as to the function of lead in LCG, explaining that *"lead oxide or tetroxide is added to achieve the following characteristics:*

- Refractive index: ratio of the speed of the light in vacuum in a dimensionless number that describes how light propagates through a medium. The higher the refractive index, the more lighting effects (rainbow).
- Abbe number: Abbe number is a measure of the variation of refractive index with wavelength so that the refractive index of a glass with a low Abbe number varies across the visible spectrum less than a glass with a high Abbe number. Lead crystal glass has a low Abbe number which reduces chromatic aberration in parallel to displaying a high refractive index.
- Dispersion: phenomenon in which the phase velocity of a wave depends on its frequency. The bigger the dispersion, the more visible spectrum of colours (rainbow).
- Cooling time: lapse of time between two viscosity states below and above which glass cannot be shaped. The more time is possible, the more specific (longer, thinner, and complex) shapes can be designed. This specificity enhances the skills of the craftsman to elaborate high end products.
- Working range: range of temperature with the same purpose of the cooling time, expressed in °C, instead of time.
- Vickers' Hardness: measure of hardness of the material. The lower the hardness, the more possibilities for cutting and engraving complex artistic designs on exceptional and prestigious items which can only be achieved by handcrafting.
- Better energy efficiency¹⁷⁶¹ because of less energy consumption together with a better lighting effect."

31.4.1 Possible Alternatives for Substituting RoHS Substances

EDG & LEU¹⁷⁶² explain that research has been conducted for over two decades, but that no viable substance substitute exists. There are a limited number of elements in the periodic table available that can be combined to form certain kinds of crystal glass in EEE applications (BaO, ZnO, SrO, CaO, MgO). Combinations that exist form glasses only

¹⁷⁶⁰ Op. cit. EDG and LEU (2015a)

¹⁷⁶¹ When asked to quantify this aspect, EDG replied that "A confidential study made by one of our stakeholders shows that for a light source of 30,9 lm/W, crystal gives 10% more light than glass leading to an 'A' category for crystal item and 'B' for some glass items." As it was not possible to understand how this study was performed from information in the public realm and as other argumentation was found to provide a relevant basis on which the review can be judged, this aspect has not been further pursued. ¹⁷⁶² Op. cit. EDG & LEU (2015a)

within relatively small composition ranges. Many combinations have been tested but a viable alternative has not yet been found. Research has provided patterns achieving some of the Pb-bound in crystal properties, but none of these patterns achieve all of the same essential properties, especially the main one: thermo-mechanical-optical properties to elaborate the product. EDG & LEU provide a comparison as presented in Table 31-1 below. The results obtained show that the required properties are not provided by investigated candidates, which displayed inferior thermal, mechanical and optical properties (cooling time, Vickers hardness, Abbe number) and that would thus not allow the manufacture of the same applications.

Table 31-1: Comparison of properties of lead crystal to lead-free crystal and and sodalime crystal

	lead crystal	lead free crystal 1	lead free crystal 2	lead free crystal 3	sodalime glass
Refractive Index	1,559	1,555	1,547	1,554	1,521
Refractive index	discrepancy	0%	-1%	ead free crystal 2 lead free crystal 3 sodalime glass 1,547 1,554 1,521 -1% 0% -2% 53,6 55,4 59,4 22% 26% 36% 3,2 3,2 3,1 -24% -24% -27% 2,7 2,7 2,6 -26% -29% -26% 5,1 5,1 4,8 -30% -31% -34% 4,3 4,2 4,0 -32% -32% -36% 290 254 298 -13% -24% -10% 113 104 100 -13% -20% -23%	-2%
Abba Number	43,8	55,7	53,6	55,4	59,4
Abbe Number	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	36%			
Dispersion (656 27mm 768 2mm) (10E 2)	4,2	na	3,2	lead free crystal 3 soda gla 1,554 1,5 0% -2 55,4 55 26% 38 3,2 3 -24% -2 2,7 2 5,1 4 -31% -3 4,2 4 -32% -3 254 22 5,1 4 -31% -3 4,2 4 -32% -3 254 29 5,11 5 4,31% -3 4,2 4 -32% -3 254 29 5431 55 13% 16	3,1
Dispersion (050,27mm-760,2mm) (10E-5)	discrepancy		-24%		-27%
Dispersion (589 2nm 656 27nm) (10E-2)	3,7	na	2,7	2,7	2,6
Dispersion (363,3nm-636,27nm) (10E-3)	discrepancy		-26%	7 1,554 1,521 0% -2% 55,4 59,4 26% 36% 3,2 3,1 -24% -27% 2,7 2,6 -26% -29% 5,1 4,8 -31% -34% 4,2 4,0 -32% -36% 254 298 -24% -10% 104 100 -20% -23%	-29%
Dispersion (425 84pm 486 12pm) (10E-2)	7,3	na	5,1	5,1	4,8
Dispersion (455,64mm-466,15mm) (10E-5)	discrepancy		-30%	-31%	-34%
Dispersion (404 66mm 425 84mm) (40E 2)	discrepancy 6,3	na	4,3	4,2	4,0
Dispersion (404,66nm-435,64nm) (10E-3)	discrepancy		-32%	crystal 3 gla 1,554 1,5 0% -2 55,4 59 26% 38 3,2 3, -24% -27 2,7 2, 5,1 4, -31% -34 4,2 4, -32% -36 254 29 -24% -10 104 10 -20% -23 5431 554	-36%
	333	271	290	1,554 1,52 0% -2% 55,4 59,4 26% 38% 3,2 3,1 -24% -27% 2,7 2,6 -25% -29% 5,1 4,8 -31% -34% 4,2 4,0 -32% -38% 254 298 -254 298 -254 298 -254 298 -254 298 -24% -10% 32% -38% 254 298 5431 5586 13% 16%	298
Working Range (T Log4 - T Log 7,65) (°C)	discrepancy	-19%	-13%		-10%
0	130	106	113	104	100
Cooling time (s)	discrepancy	-19%	-13%	-20%	-23%
Makanal Mandraga (MDa)	4799	5319	5038	5431	5586
vickers maraness (MPa)	discrepancy	11%	5%	13%	16%

Source: EDG & LEU (2015a)

Notes: Lead-free crystal 1&2 : formulations investigated during R&D works (thesis conducted by Baccarat until 2003, confidential, references upon request), Lead-free crystal 3 : US patent 2007/003237A1, Lead-free is based on US Patent. Holder is Swarowski Sodalime glass: commercial formulation used for tableware production

On this basis EDG & LEU¹⁷⁶³ conclude that lead-free glass does not fit with the required combination of essential properties.

- "Shorter cooling time/working range would not permit the production of complex items any more.
- Higher Vickers hardness will trigger musculo-skeletal disorders for the workers because the cutting difficulty will dramatically increase. In addition, quicker damage and need to replace industrial tools will drastically increase. It will

¹⁷⁶³ Op. cit. EDG and LEU (2015a)

become impossible to make very intricately engraved articles as employers are required to protect the health of their workers.

The combination of optical properties (refractive index, Abbe number, dispersion) generated by the use of lead bound in crystal glass are unique and unmatched by other materials (the latter are unable to obtain the same low value of chromatic aberration)."

According to EDG & LEU¹⁷⁶⁴ there are no industrial processable substitutes with comparable thermo-mechanical-optical properties enabling the manufacture of handmade high end articles. There is no single element or combination of elements known to substitute Pb in crystal glass in all its properties (workability, optical properties, chemical resistance, etc.). Tested combinations of elements such as Ti, B, Zn, Bi, Sb, Ba, Sr, Li, have only allowed reaching some of the above-mentioned properties. It is further explained that it is difficult to estimate if and when further research shall allow achieving the demanding combinations of essential characteristics. It is therefore not possible to predict how long this type of R&D would take or whether substitutes could be found for all the lead bound in crystal EEE applications.

31.4.2 Environmental Arguments

According to EDG & LEU¹⁷⁶⁵ the hazard represented by glass depends on the intrinsic properties of the substance glass and not on the intrinsic properties of the individual substances that went into the batch as intermediates for making the glass. By definition, glass is an amorphous, inorganic solid material made by fusing silica with basic oxides. Glass is called amorphous because it is neither a solid nor a liquid but exists in a vitreous (or glassy) state. From a chemical point of view, glass is both a unique material and a material state respectively. The chemical and physical material characteristics and behaviour cannot be derived from the properties of the raw materials (e.g., PbO or $Pb_{3}O_{4}$) used as intermediates. The melting process leads to a complete chemical transformation forming a new chemical compound: crystal glass. Lead bound in crystal glass waste is a non-hazardous waste according to EC Decision 2003/33/EC. Criteria for acceptance of non-hazardous waste at landfills have been introduced in Council Decision 2003/33/EC, also including leaching thresholds for various substances. According to EDG & LEU, LCG has been tested and lead bound in crystal complies with the leaching values of the landfill directive (see Appendix A.5.0) and is classified as non-hazardous material in the Waste Framework Directive (2008/98/EC).

It is further explained that lead crystal EEE applications are prestigious and expensive items which are kept, transferred, inherited or resold. The repairing or replacement of the broken parts, of these prestigious and expensive items (e.g. one branch or prism of a luminaire), prevents the discarding of the full EEE application. Crystal manufacturers provide inherent assistance via an after-sales service by which they collect and replace

¹⁷⁶⁴ Op. cit. EDG and LEU (2015a)

¹⁷⁶⁵ Op. cit. EDG&LEU (2015a)

the broken parts of EEE crystal items which have been brought back by the customer, sometimes via the distribution chain. In addition, there are second-hand shops and specialized repair workshops, privately collecting, repairing and replacing spare parts of EEE applications made of lead bound in crystal glass. In this sense EDF & LEU argue the **probability of LCG EEE articles to reach the waste stream** to be very small. The number of discarded spare parts is negligible, given that EEE applications made of lead crystal glass are prestigious and expensive items which the consumer has all interest to keep and repair.¹⁷⁶⁶

Finally, during the visit at the Saint-Louis manufacturing facility (see Section 31.5), both representatives of Saint-Louis and of Baccarat explained that the use of lead in the glass affects its workability and subsequently the **energy consumption of various manufacturing stages**. Saint-Louis were asked to substantiate this aspect and provided the following detail as a follow-up to the visit:

Saint-Louis¹⁷⁶⁷ explains that lead oxide included in a glass recipe has a significant contribution towards lowering the melting temperature of the different oxides, and towards extending the working range. The time within this working range is critical for handmade work, because it corresponds to the temperatures where the thermal and viscosity behaviour of the glass is suitable for glass shaping. Typically the lead oxide glasses will have longer working range by about 60-80°C (about +30% longer)¹⁷⁶⁸ in comparison to lead-free glasses. Consequently workers have more time to shape the glass before heating it again. Moreover, the thermal behaviour of lead oxide glass is shifted towards lower temperature, which means a lesser high reheating process when needed. All in all a lead oxide recipe needs less energy than a lead-free one. Saint-Louis¹⁷⁶⁹, estimates that typically the orders of magnitude of energy consumption savings and advantages for lead-glass recipes versus lead-free recipes, in relation to various processing stages are as follows:

- **Fusion**: with a nominal temperature setting of at least 50°C less for fusion in pot & tank furnaces, this translates to at least 10% less energy consumption for lead glass vs lead-free glass.
- Blowing/glass art: during shaping processes, glass is regularly reheated in different side gas furnaces, to allow the completion of all the different shaping gestures (blow gestures +hand shaping gestures) to achieve the right

¹⁷⁶⁶ Op. cit. EDG&LEU (2015a)

¹⁷⁶⁷ Saint-Louis (2015a), Answers to clarification questions following visit at the Saint-Louis manufacturing facility, sent per email 15.1.2016

¹⁷⁶⁸ In this regard please note the reference in Section 31.3: "The range of temperatures in which glass is formed into ware in a specific process. For comparison purposes, when no specific process is considered, the working range of glass is assumed to correspond to a viscosity range from the working point to the softening point. (4 to 7.6 Log10 Poise)". See also Figure 31-2: Viscosity as a function of temperature for several glass types.

¹⁷⁶⁹ Saint-Louis (2015a), Answers to clarification questions following visit at the Saint-Louis manufacturing facility, sent per email 15.1.2016

design. Lead oxide glass recipes, which have a longer working time, do not need to be reheated as often, and the needed temperature (relevant for reheating) is lower. Though it is difficult to quantify the differences in light of the diversity in the various pieces typology, it is however clear that the energy consumption relevant for making the same amount of pieces per time unit is less (estimated as about 15%).

- Annealing: with a nominal temperature setting of at least 50°C less for annealing in belt furnaces (after glass shaping and cup removing), it is estimated that as a minimum 15% less energy is consumed for lead-glass in comparison to lead-free glass.
- Every mechanical operation is affected by the change of hardness of the glass. Lead-glass is less hard than lead-free glass. As a consequence, the needed effort to modify the surface of the material is lower:
 - <u>Handmade cutting</u>: 20-50% less time is needed for completing tasks (depending on product's typology), with non-evaluated impacts on skeleton & muscular diseases.
 - <u>Machine cutting</u>: 15% less power is needed for the completing the same tasks.
 - <u>Flat surfacing & final polishing</u>: surface polishing is highly dependent on the hardness; lead glass flat surfacing time as compared to leadfree recipes is estimated to be about 75% less energy intensive, and for final polishing and reparation this difference is estimated to be about 35% less. Consequently, energy saving is expected to greater in lead glass.
 - <u>Etching acid polishing</u>: The acid polishing process is comprised of a succession of dipping into different baths of hydrofluoric (HF) & sulfuric (H₂SO₄) acids, enabling chemical attacks of the glass surface and cleaning ones. This process occurs at 50°C. The chemistry of a lead glass reacts differently to the acid attacks of lead-free glass because of the atoms network bonding and chemical affinities, which influences the chemical reactions at the surface. For lead-free glass, it has been observed that the cleaning of the chemical substances from the acid attack is favourable when hydrochloric (HCI) acid is added to the HF and H₂SO₄, which means higher costs and energy, not yet quantified. According to the tests carried out, for the global etching process, typically 60% less time is needed for lead glass as compared to lead-free glass, which means directly 60% less energy consumption.
- **Decoration**: the firing process of gold palladium coatings is done in batch furnaces at temperatures which are at least 50°C lower for lead-glass recipes in comparison to lead-free glass, which means about 15% less energy.

Saint-Louis¹⁷⁷⁰ concludes that all in all, the estimated energy saving along the production stages of crystal lead glass in comparison to lead-free glass is between 20-30%. Concerning possible differences in the maintenance of equipment, the frequency at which cutting wheels need to be sharpened and replaced is around twice less (Saint-Louis's terminology).

31.4.3 Socio-economic Impact of Substitution

EDG & LEU¹⁷⁷¹ argue that the ban of lead crystal in electric and electronic equipment would lead to the disappearance of some mainly lead crystal manufacturing companies. In Europe there are many companies whose business is devoted entirely to the production and sale of lead crystal chandeliers and allied lighting products (e.g. in UK approximately 10). A larger group of companies have lead crystal products as part of a wider range of products (e.g. in UK approximately 25) and there are a number of specialist antique restoration companies that refurbish and restore lead crystal chandeliers and rely on the manufacture of spare parts made from the same quality of crystal glass (e.g. in UK approximately 5). LCG is manufactured mostly through artisanal work, requiring unique and specific knowledge, with some European companies benefitting in this respect from national recognition for this via a status of patrimonial knowledge. EEE applications represent about one third of the turnover for some of these companies. Should the exemption not be renewed, it would mean:

- Loss of economic and patrimonial wealth.
- Loss of circa one third of turnover of related manufacturing companies and in the medium/long term, their disappearance.
- Loss of 1,000 direct jobs and 3,000 indirect jobs¹⁷⁷² in Europe.

If lead crystal were to be banned in the EU the high quality market for chandeliers and other allied lighting products would be severely affected as the distinction between high quality chandeliers (some costing 10s of thousands of EUR) and poorer quality items will not exist. As a result the market for high quality crystal lighting will be damaged and some companies may be forced out of business with a resulting loss of jobs. A similar damage will affect the restoration and refurbishment market as lead crystal parts matching the originals would not be available rendering their work as poor restorations (bearing in mind that refurbished lighting products need to comply with relevant regulations). If the market does not exist there would be no replacement part available.¹⁷⁷³

¹⁷⁷⁰ Op. cit. Saint-Louis (2015a)

¹⁷⁷¹ Op. cit. EDG & LEU (2015a)

¹⁷⁷² Indirect jobs are understood to be related to enterprises which use lead crystal in their work, however which do not manufacture the lead crystal themselves. For example, manufacturers of articles who rely on lead crystal producers as suppliers, enterprises who repair items (e.g. through replacement of single items that have broken, etc.).

¹⁷⁷³ Op. cit. EDG & LEU (2015a)

In a later communication it is understood that a large share of the manufacture of LCG for EEE articles relies on hand crafting and manual processing. Chandeliers, floor lamps, candelabras, table lamps, wall sconces, luminaires are made in crystal glass. Those lead crystal glass items are mainly hand crafted even if some parts could be industrially processed. For example a chandelier requires from 500 to 1,750 worked hours.

Hand crafting is said to represent 85% of work time, of the cold processing parts, for chandeliers, floor lamps, candelabras, table lamps, wall sconces and luminaires, . The remaining 15% of the work time utilises an automated tool. Equivalent additional worked hours should be taken into account for forming the part - all these additional hours are hand-crafted. Even for items where the main blank shape is produced by machine (picture frames, clocks etc.), the manual work content is approximately 80% of the manufacturing cost. Besides, most of the items manufactured by EDG-Member factories and workshops are unique. Each of them is a creation or issued in a limited edition. There is no mass production: ¹⁷⁷⁴

- For horology, production is about hundreds per year per producer;
- For chandeliers, total production volume is a little more than a thousand per year in Europe.

31.4.4 **Roadmap to Substitution**

General statements were made by the applicant as to the lack of available substitutes despite the research efforts that had been carried out in this area over the years. Following the visit at the Saint-Louis manufacturing facility (see Section 31.5) and the understanding from both Saint-Louis and Baccarat that manufacturers were actively researching possible alternatives to the use of lead in lead-crystal handmade articles, Saint-Louis were asked to substantiate the various aspects of their research.

In this respect, Saint-Louis¹⁷⁷⁵ explains the production of a lead crystal piece to be a succession of different sub-processes, gathered in hot and cold areas. In total, this includes more than 20 sub-processes, with flows depending on the product typology. The table below illustrates 3 different production flows (in green) for 3 typical luminaire crystal parts.

The complexity (i.e. of the research of potential substitutes) takes place intrinsically in the different flows that need to be tested but also in the interactions between the different sub-processes. In other words, the evaluation/development of a sub-process n+1 may necessitate the modification of a sub-process n or of the glass recipe itself,

¹⁷⁷⁴ EDG & LEU (2015b), European Domestic Glass and LightingEurope, Answers to 1st Clarification Questions regarding Exemption 29 in Annex III of Directive 2011/65/EU, submitted on 14.08.2015, available under:

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_29/20150814_Ex_29_ EDG LEU 1st round of Clarification-Answers final-Public.pdf ¹⁷⁷⁵ Op. cit. Saint-Louis (2015a)

which would require to check / adjust again other sub-processes: setting the recipe is an iterative development which needs to be proved for repeatability and reproducibility regarding handmade and product diversities. ¹⁷⁷⁶

hot processes ability \leftarrow impacts glass recipe \rightarrow cold processes ability

At each stage, on one hand the product parameters are evaluated according to Saint-Louis quality standards expected by customers (Norme de Choix), and on the other hand in respect to the process performances (reject levels, energy consumption, maintenance impacts). For instance, the thermal and viscosity behaviour of one recipe could be found suitable for blowing processes, but not for injection/pressing processes, which means a correction of the recipe and a new check of the blowing performance would be needed. However, a change of the recipe also affects the fusion properties, particularly the refining process, which is key aspect for producing a high quality glass without bubbles. Another example of interaction is the impact of a recipe modification on the chemical behaviour during the etching process (acid attack), and on the aptitude of gold or platinum decoration (decor adhesion on the glass substrate during the firing decoration process).¹⁷⁷⁷

¹⁷⁷⁶ Op. cit. Saint-Louis (2015a) ¹⁷⁷⁷ Op. cit. Saint Louis (2015a)

¹⁷⁷⁷ Op. cit. Saint-Louis (2015a)

Table 31-2: Example of 3 different production flows (in green) for 3 luminaire pieces

	Fu	sion	Hot processes					Cold processes						
glass or	i tion Il mixing	fusion tank furnace	blowing injection	glass annealing tunnel oven	cup removing laser	ishing	ſ	flat polishing handmade cuts machine cuts	ing			oration Ig		
		l mixi	pressing			lod ət	ealin	engraving	ngrav	shing	ishinç tion	n deci & firi		
hurricanes	mpos lateria	fusion	paperweight	glass	cup	s flan	sanr	drilling / neck tooling	ical e	lod b	al pol epara	adiur ation		
for luminair	co raw m	pot furnaces	glass art	annealing batch oven	removing saw	cut edge	glas	sand blasting	chemi	acio	fina	Gold/pall. applic		
								flat polishing						
		fusion tank	blowing	glass annealing	cup removina	бu		handmade cuts				ion		
colored	furnace furnace furnace furnace furnace furnace	furnace	injection	tunnel oven	unnel oven laser	laser il	nishi Jg	machine cuts	ving	6	6	corati 'ing		
hurricane		pressing paperweight glass	me po	engraving	ngra	ishin lishir	lishir ation	m de ո& fir						
holder			fusion	paperweight	glass	cup	s flar	ss anı	drilling / neck tooling	iical e	lod bi	al po epara	ladiu catior	
for luminair	u na co	pot furnaces	glass art	annealing batch oven	ing removing by the saw	cut edge gla	bla	sand blasting	chem	ac	fin	Gold/pal appli		
	fusion		fusion tank	blowing	glass annealing	cup	6L		handmade cuts				uo	
	king	furnace	injection	tunnel oven	laser	laser il	laser	бu	machine cuts	ving	6	6	corati 'ing	n
branch for luminair	sitior al mi>	fusion pot furnaces	pressing	glass	cup	s flame po	ss annealir	engraving	ical engra	d polishin	lishir ation	adium de c ation & fir	etal catio	
	mpo nateri.		paperweight					drilling / neck tooling			al po epara		to m + sctrifi	
	co raw m		glass art	annealing batch oven	removing saw	cut edge	gla	sand blasting	chem	aci	fin	Gold/pall applic	sealing ele	

Source: Saint-Louis (2015a)

Fusion is the key starting process, which cannot be tested directly with final production furnaces (tank or pots). Indeed recipes evaluation and pre-validation must start with crucibles at the laboratory and in small size pots with limited trials, enabling the production of some pieces for testing performance in respect to shaping and cutting and challenging their hot/cold processes ability, leading finally to real size pots and extensive validations. Consequently, the use of a tank furnace ought to be done at the end of the development of all the sub processes with the final glass recipe selected, with the help of the tank furnace supplier where designing of the right furnace is of relevance.¹⁷⁷⁸

Colours development is also a key issue for the product portfolio in relation to expectations of customers and designers, for luminaires as well as for decoration and tableware. A dozen colours are currently made available by Saint-Louis on the market. Many coloured products are made of overlaid glass colours. The glass colours must be developed on the basis of the clear recipe, for dilatation coefficient and fusion compatibility reasons. Furthermore, the effect of the colorant oxides strongly depends

¹⁷⁷⁸ Op. cit. Saint-Louis (2015a)

on the glass matrix. Therefore the development of the different colours must be synchronized once the clear recipe is known, and this cannot be fully anticipated and induces a time shift as well in respect to the time needed for enabling substitution.¹⁷⁷⁹

Saint-Louis¹⁷⁸⁰ explains that as indicated in the presentation held during the visit on 3 December 2015 (detailed in Section 31.5), the overall recipe development for a substitute is thus based on a progressive, iterative and focusing approach following several criteria which must be validated with each other. So far, after desk-research (of between 1 to 600 recipes) and experimental tests with crucibles (of between 1 to 20 recipes), between 1 and 10 recipes are currently being tested in small pots, and Saint-Louis has initiated real pot evaluation of between 1-5 recipes. It took about 5 years to arrive at the mapping of results for processes performance, shown in the presentation for the hot and cold areas. On this basis it is expected that at least 10 more years shall be needed to achieve the final focus on one recipe and its optimization, in order to cope with the different sub-processes relevant for producing the product portfolio of the luminaires and other pieces manufactured by Saint-Louis. Against this background, Saint-Louis however also notes that there is no guarantee of success at this stage.

31.5 Visit of LCG Manufacturing Facility

During the evaluation period EDG coordinated a visit of the consultants at the manufacturing facility Saint-Louis¹⁷⁸¹, located in the Lorraine region of France. During the visit the various stages of the manufacturing process were observed, including:

- Manufacture of pots from special clay, used for the fusing of the lead crystal glass in the second stage in the "multi-pot" furnaces – the composition of the clay is specifically determined for the LCG composition and will need adaptions should the composition of the glass change;
- First fusion in furnace of the intermediate ingredients into clear lead crystal glass. Most facilities will have a unique glass composition making separation of manufacture to lead-free articles and lead-based articles impractical;
- Second fusion in multi-pot furnaces of the lead crystal glass as preparation for hot processing of articles. In this stage metal oxides can be added to the clear crystal glass to determine the colour of a specific batch of glass;
- Hot processing of lead crystal glass blowing as well as glass pressing (manufacture of articles with moulds). In the process of forming, the articles are reheated as necessary to provide sufficient forming time – the working range of the glass determines how many times the article is to be reheated until the hot process forming is completed;

¹⁷⁷⁹ Op. cit. Saint-Louis (2015a)

¹⁷⁸⁰ Op. cit. Saint-Louis (2015a)

¹⁷⁸¹ The visit at Saint-Loius (See <u>http://www.saint-louis.com/en/</u> for details) took place on the 3.12.2015 and was also attended by representatives of EDG, the French Federation of crystal manufacturers and Baccarat (another French lead crystal manufacturer).

- Belt and static furnaces are used to anneal articles after they are blown/pressed to relieve inner tensions and "relax" the material;
- Cold processing of lead crystal articles depending on the type of article being produced, this stage may include: cutting, engraving, polishing, etching and gold decoration. At this stage the hardness of the glass impacts the processing time, subsequently determining the wear of machinery.

It was explained that the refraction of lead glass plays an important role for lighting products and thus that engraving and cutting processes, which are easier when lead is present, are more common to create more intense refraction effects. From the current research it can already be seen that certain types of cutting processes are impossible to achieve with lead-free crystal, as lead-based crystal glass is softer.

Furthermore, Saint-Louis presented results of their on-going research efforts into alternatives. It is understood that the search for lead-free recipes was motivated years ago by the regulation of lead, e.g. under RoHS and by the ongoing discussions about food contact and REACH. According to Saint-Louis, the general goal is to find an alternative glass recipe which shall allow manufacturing products with the unique properties relevant both for manufacture and for the end product. A new composition needs to show similar properties throughout all stages of manufacture and processing while also resulting in articles with the same gualities as LCG (refraction of light, the clearness of the glass, etc.). To begin with, candidate substitutes need to have a similar density and to exhibit similar refraction properties. Furthermore, candidates will need to be tested to see their performance through the various production phases, to ensure that the same articles can be manufactured with comparable quality. Saint-Louis have identified over 20 sub-processes within the manufacture for which potential compositions need to be checked, as well as checking the internal relations between these processing stages. The need to use a single composition for manufacturing a relatively wide product portfolio further complicates the search for a suitable alternative, as a potential substitute composition shall need to enable manufacture of a wide variety of different products¹⁷⁸². Aside from ensuring the technical comparability of candidate substitutes, it is also necessary to ensure that negative health and environmental impacts shall not be a result of substitution. In this respect, if the weight or the hardness of the material

¹⁷⁸² In this respect, the consultants can follow that the use of both the first fusion furnace and of the multipot furnace in the manufacturing process may limit the practicability of manufacturing in separate batches. This is because for each batch, all furnaces would need to be cleaned from any residues, which may affect the recipe composition and thus the properties of the crystal in subsequent production stages and in the final products. Furthermore, Saint-Louis has also mentioned the need to optimise the composition of the clay used for the pots in the multi-pot furnace, should a new composition be found to be a practical substitute. It has also been communicated that possibly the machines used from cold processing would need to be adapted in light of differences in the hardness of the material. In this sense, it can be followed that batch production that may allow using a lead-free or lead-reduced formula for certain articles and lead based for others, would not be practical. Though theoretically it is possible that multiple production lines could be constructed, this would only be practical in facilities above a certain size of production.

change, this may influence the workability of articles for employees, as well as influencing the time needed for certain processes and thus the energy consumption or the wear of machinery. If the composition shall have a higher fusing temperature and/or a shorter work range, this would also increase the time needed for various process stages as well as the energy consumption. Furthermore, depending on the substances that shall compose the substitute, toxicity aspects may also need to be considered.

31.6 Stakeholder Contributions

The following stakeholders contributed to the stakeholder consultation regarding Ex. 29 and all support the renewal of the exemption:

- Academie de Clermont- Ferrand, Lycée Jean Monnett (Academie de C-F);¹⁷⁸³
- Assemblée Nationale, Jacques Lamblin, Député de Meurthe et Moselle, Maire de Lunéville (Maire de Lunéville);¹⁷⁸⁴
- Assemblée Nationale, Céleste Lett, Député de la Moselle, Maire de Sarreguemines (Maire de Sarreguemines);¹⁷⁸⁵
- Assemblée Nationale, Gérard Cherpion, Member of the French Parliament, Member of the regional Council of the region Lorraine (Gérard Cherpion);¹⁷⁸⁶
- Association of the Glass and Ceramic Industry of the Czech Republic (ASKPCR);¹⁷⁸⁷
- Canning Design Ltd (Canning Design);¹⁷⁸⁸
- Cerfav, CRT- Verre (Cerfav);¹⁷⁸⁹

¹⁷⁸⁵ Maire de Sarreguemines (2015), Assemblée Nationale, Céleste Lett, Député de la Moselle, General comments related to RoHS exemption package 9, submitted 15.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_29/contribution_by_c</u> eleste_LETT.pdf

¹⁷⁸³ Academie de CF (2015), Academie de Clermont-Ferrand, Lycée Jean Monnett, submitted 19.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_29/</u> <u>Ex_29_lycee_Jean_Monnet_zusammengefuegt.pdf</u>

¹⁷⁸⁴ Maire de Lunéville (2015), Assemblée Nationale, Jacques Lamblin, Député de Meurthe et Moselle, Maire de Lunéville, General comments related to RoHS exemption package 9, submitted 12.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_29/</u> <u>Courrier_RoHS_anglais.pdf</u>

¹⁷⁸⁶ Gérard Cherpion (2015), Assemblée Nationale, Gérard Cherpion, Member of the French Parliament, Member of the regional Council of the region Lorraine, General comments related to RoHS exemption package 9, submitted 15.10.2015, available under: • Assemblée Nationale, Gérard Cherpion, Member of the French Parliament, Member of the regional Council of the region Lorraine

¹⁷⁸⁷ ASKPCR (2015), Association of the Glass and Ceramic Industry of the Czech Republic, submitted 16.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/</u> <u>Exemption 29/Ex 29 ASKPCR 16102015.pdf</u>

¹⁷⁸⁸ Canning Design (2015), Canning Design Ltd., submitted 16.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_29/Ex_29_CanningDe</u> <u>sign_Consultation_Document151015.pdf</u> ¹⁷⁸⁹ Cerfay (2015), CPT_Vierre_submitted 10.10.2015, available under:

¹⁷⁸⁹ Cerfav (2015), CRT- Verre, submitted 19.10.2015, available under: <u>http://rohs.exemptions.oeko.info/</u> fileadmin/user_upload/RoHS_Pack_9/Exemption_29/Ex_29_Cerfav_20151016.pdf

- CFE-CGC Chimie (CFE- CGC);¹⁷⁹⁰
- Confédération française des métiers d'art de l'exellence et du luxe- French Confederation of Arts and Crafts (CFMA);¹⁷⁹¹
- Fédération CFTC Chimie Mies Textile Energie (CFTC- CMTE);¹⁷⁹²
- Institut Universitaire de France, Ecole Nationale Supérieure de Chimie de Clermont- Ferrand (Institut Universitaire de France);¹⁷⁹³
- John Rocha, CBE (John Rocha);¹⁷⁹⁴
- José Lévy, Design expert (José Lévy);¹⁷⁹⁵
- Parlament Européen, Députée Européene ADLE/ Grand Est- France (Députée au Parlament européen);¹⁷⁹⁶
- Direction de l'Economie Solidaire et de l'Insertion, Conseil Départemental de Meurthe-et-Moselle (Meurthe et Mosselle)¹⁷⁹⁷;
- La Région Lorraine, Le Président du Conseil Régional de Lorraine, Sénateur de la Moselle (Région Lorraine);¹⁷⁹⁸

¹⁷⁹⁰ CFE- CGC (2015), CFE- CGC Chimie, French trade union, submitted 19.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_29/Ex_29_CFE-CGC_Chimie_reponses_questions_20151016.pdf</u>

¹⁷⁹¹ CFMA(2015), Confédération française des métiers d'art de l'exellence et du luxe- French Confederation of Arts and Crafts, Application to exemption No 29 of crystal glass a part of the directive RoHS 69/493/EEC, submitted 13.10.2015, available under:<u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/</u> RoHS_Pack_9/Exemption_29/Contribution_by_confederation_francaise.pdf

¹⁷⁹² CFTC- CMTE (2015), Fédération CFTC Chimie Mies Textile Energie, submitted 19.10.2015, available under: <u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_29/</u> Ex. 29. EEDERATION_CETC-CMTE_Position_20151016_ENG.pdf

Ex 29 FEDERATION_CFTC-CMTE_Position_20151016_ENG.pdf ¹⁷⁹³ Institut Universitaire de France (2015), Ecole Nationale Supérieure de Chimie de Clermont- Ferrand, submitted 15.10.2015, available under:<u>http://rohs.exemptions.oeko.info/fileadmin/user_upload/</u> <u>RoHS_Pack_9/Exemption_29/Contribution_Exe_29.pdf</u>

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- Lyceé Dominique Labroise, The Headmaster, F. Vignola (Lyceé Dominique Labroise);¹⁸⁰⁰
- Ministry of Industry and Trade of Czech Republic, Vice Minister, Ing. Eduard Muricky (Ministry of Industry/ Trade of Czech Republic);¹⁸⁰¹
- Moselle Department Council, Le president (Moselle Department);¹⁸⁰²
- Noé Duchaufour Lawrance, pour Néonata S.A.R.L. (Noé Duchaufour Lawrance):¹⁸⁰³
- Test and Measurement Coalition (TMC);¹⁸⁰⁴ .
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A short summary of the aspects raised by the various stakeholders is provided in Table 31-3.

Table 31-3: Summary of	aspects	related t	o Ex.	29	raised	in stak	eholder
contributions							

Aspect	Stakeholders
Lack of substitutes for lead oxides in the manufacture of LCG, despite research efforts of manufacturers.	Meurthe et Mosselle; Senateur des Vosges; Maire de Lunéville Senateur de la Moselle; CFMA; Moselle Department; Maire de Sarreguemines; Institut Universitaire de France; PRECIOSA, Cfdt; Ministry of Industry/ Trade of Czech Republic. ASKPCR; Cerfav; CFTC- CMTE
Unique properties obtained through the use of lead in LCG – optical properties, aesthetic properties, improved working properties (increase of the viscosity of the material), allows the production of specific articles.	Meurthe et Mosselle; Maire de Lunéville; CFMA; Région Lorraine; Maire de Sarreguemines; PRECIOSA; José Lévy; Lyceé Dominique Labroise; Noé Duchaufour Lawrance; Cfdt; Ministry of Industry/ Trade of Czech Republic; John Rocha; Canning Design; Cerfav; CFTC- CMTE; Academie de CF
Properties that enable energy savings in the manufacture of LCG related to the use of lead as an intermediate.	Meurthe et Mosselle; Maire de Lunéville; PRECIOSA; Lyceé Dominique Labroise; Cfdt; CFTC- CMTE
Low probability of articles to reach the waste stream (i.e. to reach end-of-life). Subsequently, no significant environmental impact expected related to collection, replacement, repairing.	Meurthe et Mosselle; Senateur des Vosges; Senateur de la Moselle; CFMA; Moselle Department; Députée au Parlament européen; Maire de Sarreguemines; PRECIOSA; José Lévy; Lyceé Dominique Labroise; Noé Duchaufour Lawrance; Cfdt; ASKPCR; Cerfav; CFE- CGC; CFTC- CMTE; Academie de CF
Lead crystal used in EEE is handcrafted (artisanal) and comprises a cultural heritage of importance in various EU countries; the exemption does not relate to articles in mass production.	Meurthe et Mosselle; Senateur des Vosges; Assemblée Nationale; Moselle Department; Région Lorraine; Députée au Parlament européen; PRECIOSA; Lyceé Dominique Labroise; Gérard Cherpion; Cfdt; Ministry of Industry/ Trade of Czech Republic; John Rocha; ASKPCR; CFE- CGC; CFTC- CMTE; Academie de CF
Many individuals depend on the further manufacture of EEE containing lead crystal items for their livelihood – should the exemption be revoked, this could have a high social impact on such individuals, of particular concern in certain peripheral areas where the local population depends on such manufacturing establishments for employment (e.g. Lorraine in France, North of Bohemia (Kamenicky Senov), etc.).	Meurthe et Mosselle; Senateur des Vosges; Maire de Lunéville; Senateur de la Moselle; Moselle Department; Région Lorraine; Députée au Parlament européen; Maire de Sarreguemines; PRECIOSA; Lyceé Dominique Labroise; Gérard Cherpion; Cfdt; Ministry of Industry/ Trade of Czech Republic; ASKPCR; CFTC- CMTE
The validity period of Ex. 29 in relation to articles in sub-category 9, industrial monitoring and control instruments.	TMC

31.7 Critical Review

31.7.1 REACH Compliance – Relation to the REACH Regulation

Appendix A.1.0 of this report lists Entry 30 in Annex XVII of the REACH Regulation, stipulating that lead compounds shall not be placed on the market, or used, as substances, constituents of other substances, or in mixtures for supply to the general public. Entry 63 restricts the presence of lead and its compounds in various articles. A prerequisite to granting the requested exemption would therefore be to establish whether the intended use of lead in this exemption request might weaken the environmental and health protection afforded by the REACH regulation.

In the consultants' understanding, the restriction for lead compounds under Entry 30 of Annex XVII does not apply to the use of lead in this application. Pb used in lead crystal glass, in the consultants' point of view is not a supply of lead and its compounds as a substance, mixture or constituent of other mixtures to the general public. The lead oxides used to form the glass undergo a change of form when the ingredients are fused together. As the applicants explain, though its constituents are closely linked together, lead crystal is different from the initial state of its raw materials. In this sense lead is encapsulated in the vitreous material and thus not accessible to the public as such. Pb is part of an article and as such, Entry 30 of Annex XVII of the REACH Regulation would not apply.

Entry 63 of Annex XVII restricts the use of lead and its compounds in various articles. Paragraph 1 specifies jewellery in this respect, however paragraph 4(a) specifically excludes "crystal glass as defined in Annex I (categories 1, 2, 3 and 4) to Council Directive 69/493/EEC (*)" in relation to paragraph 1. Paragraph 6 does not allow placing articles on the market which, contain Pb concentrations above 0.05% by weight, where during normal use these could be placed in the mouth by children. Nonetheless, paragraph 7(b) specifically excludes "crystal glass as defined in Annex I (categories 1, 2, 3 and 4) to Directive 69/493/EEC"; It is thus concluded that this entry would not apply to Pb in lead crystal glass used in EEE. Paragraph 8(k) also further excludes equipment in the scope of RoHS from the paragraph 7 restriction.

No other entries, relevant for the use of lead in the requested exemption could be identified in Annex XIV and Annex XVII (status December 2015).

Based on the current status of Annexes XIV and XVII of the REACH Regulation, the requested exemption would not weaken the environmental and health protection afforded by the REACH Regulation. An exemption could therefore be granted if other criteria of Art. 5(1)(a) apply.

31.7.2 Scientific and Technical Practicability of Substitution

EDG and LEU have requested the renewal of exemption 29 to allow the use of Pb in lead crystal glass when used in EEE. The applicants argue that lead provides unique properties to the crystal glass, which are of importance both in the manufacture of articles as well as in the performance of the product through its use.

The properties of the lead crystal glass are explained to be of importance for the end product, as the addition of lead affects optical properties and thus the aesthetic properties of the glass, such as the refractive index and the dispersion of light. This is explained to be important, as it allows designers of articles to create unique products, and is also of importance to consumers judging by the demand for such products on the market.

EDG and LEU argue that there are no comparable substitutes for lead crystal glass that would provide the same properties and performance both in the manufacture and in the products themselves. The production of lead crystal glass used in EEE includes a large degree of hand crafting, both in the manufacturing stages, such as blowing and pressing and in the later stages of cold processing such as cutting and polishing. Even when automation is involved in the manufacture, EDG & LEU claim that up to ~80% of the production costs are related to further handcrafting of the articles. The properties of the material are understood to have a large effect on the ability to perform the various stages of the production, particularly in the manual processing stages, and it can be understood that substitutes that have been tested up until now would not allow creating articles of the same complexity. This would also affect the time needed for production and thus respectively the energy consumption (estimated by Saint-Louis to be at least 20-30% lower than were lead-free glass to be applied).

It can be understood that the various lead crystal manufacturers have been researching substitutes for many years, and results of this research also show certain progress in this respect. However, it is also understood that an alternative to lead in the glass which is applicable to all stages of the production, is not yet available and that lead crystal glass is at present still the only material that would allow retaining the diverse product range. Where first attempts (production of articles in small scale and testing of their suitability in various processing stages) have been performed with lead-free glasses, it can be followed that results are not yet sufficiently comparable to allow the substitution of lead, and that such results also suggest that substitution at this stage would result in a significant increase of energy costs and use of resources.

Though one could argue that for the various EEE articles, in which lead crystal is used, that various alternatives exist – e.g. alternative luminaires – the consultants can follow that such articles would not provide a one-to-one replacement in terms of the appearance of the products. Though this aspect is understood to be of aesthetic nature, being difficult to assess in technical terms, some data has been provided to show that should other types of glass be used to create articles of similar appearance, that the optical properties of importance for the aesthetic properties of the products would not be comparable on the crystal level. Alternative types of glass, regardless of their ability to be used for creating products of the same complexity, show inferior levels in terms of e.g. refractive index, abbe number, dispersion, etc.

It is understood that in manufacture, the addition of lead increases the working time of the glass through its impact on the viscosity of the glass and its thermal properties. This facilitates the melting and forming of crystal articles in hot-processing, and more importantly has an impact on the energy consumption related to these production

stages as the glass does not need to be reheated (re-melted) as often, and as the temperature for reheating is significantly lower than for lead-free glass types.

It is also understood that the addition of lead results in a glass that is not as hard, and in this respect the glass crystal also facilitates cold processing of the articles such as cutting, engraving, polishing, etc. Since the glass is softer, it can be processed more easily and in less time for the same amount of units, therefore also reducing the energy consumption related to these stages. Another important aspect in this respect is understood to relate to the softer lead-based glass also resulting in less frequent maintenance and replacement of equipment, which would translate to a lower use of resources where equipment or equipment components need to be replaced.

31.7.3 Environmental Arguments

The applicants, as well as some of the stakeholders, who participated in the consultation, explain that in LCG articles, lead is encapsulated within the material and a risk of emissions to the environment during the use and the end-of-life phases is not expected. The risk related to the end-of-life stage is further assessed to be irrelevant, claiming that practices of repair or replacement of the broken parts, of these prestigious and expensive items (e.g. one branch or prism of a luminaire), prevents the discarding of the full EEE application at end-of-life. EDF & LEU thus argue that the probability of LCG EEE articles to reach the waste stream is very small. EDF & LEU have furthermore submitted lead crystal leaching testing results (one report can be viewed in Appendix A.5.0) showing that the risk of lead emissions from such articles is negligible. In the consultants' view, submitted test results sufficiently show that (under normal use/ environmental conditions) emissions from lead crystal during use and during end-of-life are not expected. As long as not treated with strong acids, release of lead from the vitreous matrix would not be expected. The consultants can also follow that lead crystal articles would typically not reach the waste stream in light of their value. Small parts may become waste when broken and repaired; however it can be followed that typically articles will not be disposed of, but rather sold to antique shops and the likes. This is particularly understood to be the case for EEE articles, which as opposed to tableware are less at risk to break during use (chandeliers and luminaires shall usually be fixed to walls and ceilings, etc.). This means that possible emissions at this stage would be less significant in light of the amount of lead crystal potentially disposed of. Possible emissions of lead at these life cycle stages are thus understood to be sufficiently controlled.

A further important aspect raised in relation to environmental impacts is related to the consumption of energy and resources during the manufacture of articles. It is further expected that lower energy consumption would subsequently mean lower emissions related to energy such as greenhouse gases. These aspects have been summarised in Section 31.7.2 and are not discussed here again.

31.7.4 Socio-Economic Impacts

The applicants and the various stakeholders who participated in the consultation also argue that to revoke the exemption could result in significant social costs, as the production of hand-crafted lead crystal is considered a cultural heritage in many areas of the EU (e.g. Alsace Lorraine in France, Bohemia in the Czech Republic, etc.). Furthermore, it is explained that in areas where this traditional form of hand crafting of LCG is performed, that facilities employ a large number of individuals, whose livelihood would be at risk should the use of LCG in EEE be prohibited. Manufacturers claim that respective market shares of LCG articles used for tableware and for EEE are changing, with a growing importance of EEE in the product portfolio. This would further support that a change to the current exemption could have a significant impact on the LCG sector. The consultants can follow that the artisan manufacture of lead crystal articles has importance both as a cultural heritage and as a source of employment for many individuals. However, it is also possible that a reduced manufacture of lead crystal (i.e., LCG applied in EEE) would in parallel lead to increased manufacture of alternative equipment (alternative luminaires, etc.) and thus to an increase of employment in other sub-sectors. Nonetheless it is difficult to estimate the total possible impacts of a revocation of the exemption, and thus the consultants cannot conclude as to the range of such impacts and their severity in terms of costs for society.

31.7.5 Stakeholder Contributions

The stakeholder contributions generally support the request, raising various aspects related to the properties of lead crystal and the unavailability of comparable substitutes. As these aspects are addressed in the summary of information provided by the applicants and by Saint-Louis, further detail is not provided here.

The contribution submitted by TMC raises a legal question as to the availability of the current exemption to category 9 equipment. Regardless of TMCs claims as to the availability of Annex III exemptions to sub-category 9 industrial for 7 years starting in 22.7.2017, in the case of Ex. 29 the wording formulation limits its applicability to crystal glass. Though in theory, such glass could be used in Cat. 9 products, this aspect has not been raised by the applicant or other stakeholders to be an area of application. Furthermore, should such glass be used as a component in such EEE, it would still benefit from the exemption as long as it is valid. Should substitutes become available however, it would be of importance to evaluate their applicability in all possible applications at the same time. In this sense, in the consultants opinion, though some Cat. 9 products could enjoy a validity period of the current exemption up till 2024 (Cat. 9 industrial), it would still be considered beneficial to align the exemption validity of all categories. Further supporting this view is the fact that the applicants who represent manufacturers of the relevant articles have not specified Cat. 9 as a category into which their articles fall.

31.7.6 The Scope of the Exemption

The consultants can follow that the search for lead-free crystal glass alternatives is still on-going. Furthermore, despite the fact that alternatives are not yet sufficiently

developed, it can be understood that where tested in small scale, such alternatives would also increase energy and resource consumption related to various production stages. The information made available to support these understandings is, however, based on practices of the artisanal manufacture of lead crystal glass, which involves a large degree of hand-crafting, as practiced for example by Saint-Louis. It is not clear if lead crystal glass articles for which the exemption is needed would also be produced through automated manufacture, nor whether the same argumentation would apply. Furthermore it is currently unclear whether in such articles the same concentration or lower concentrations of lead are present. In this sense, the question arises, whether the exemption should be limited to articles produced through artisanal manufacturing or if different concentrations of lead could be specified.

From the information provided, it can be followed that the various benefits related to the addition of lead would be equally relevant as long as similar glass formulas are used. Though the ease of processing related to glasses with a longer working range and glasses that are softer can be understood to be more relevant to hand-crafting, in light of such processes not being "controlled through automation", the reduced energy and resource consumption are understood to be relevant for both types of manufacture as the production stages would be similar in this respect (fusing temperatures of glass, cold processing with equipment). In this sense if automated production uses similar glass formulas, it can be assumed that the argumentation would apply similarly to such articles. However, if similar formulas are not used and the exemption is not needed for such production, the consultants do not think that it would be practical to exclude such articles from the exemption. The consultants are not aware of a mechanism for differentiating between articles that are hand crafted and articles that are made with automation that could be used by market surveillance to ensure enforcement.

In this sense, though it is difficult to determine to what degree the justification is relevant to articles produced with automation, limiting the exemption to hand-crafted articles would not be considered to be practical in terms of its enforcement. It could also limit the ability of manufacturers to combine automated components in some cases in order to increase competitiveness through the reduction of production costs related to hand crafting where this is possible. The consultants thus do not recommend a change of the current exemption wording formulation.

31.7.7 Conclusions

Article 5(1)(a) provides that an exemption can be justified if at least one of the following criteria is fulfilled:

- their elimination or substitution via design changes or materials and components which do not require any of the materials or substances listed in Annex II is scientifically or technically impracticable;
- the reliability of substitutes is not ensured;
- the total negative **environmental**, **health and consumer safety impacts** caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof.

In the consultants' opinion, it can be followed that substance substitutes for lead in glass are currently not available. Though changes in the ingredients of the glass have been the subject of research for many years, it can be followed that at present such a substitute would not allow sufficient replication of the product portfolio in terms of production of articles with comparable properties. Such a substitute is currently not considered available, early phase-in of a substitution candidate still under investigation would limit both the complexity of articles that could be produced as well as resulting in a significant rise in energy consumption and use of resources related to manufacture. Such a substitution is also not understood to provide comparable products in terms of their optical properties, of importance for the consumer.

In parallel, one could argue that the need for lead could be eliminated through the shift to other articles, i.e. other luminaires (possibly not from glass and of different shape and form). If for example the function of a luminaire is only to provide light or also to provide a certain appearance. In the case of crystal luminaires, the applicants have communicated that certain optical properties of the glass are established in the luminaire through the use of lead: a high refractive index, a high dispersion and transmission of light and sharp colour transition. In this sense, for an alternative luminaire to be considered as a one-to-one replacement, it would need to have similar properties and to perform on a comparable level. Where alternative glass types are used to produce crystals for use in the assembly of similar luminaires, it can be understood from the applicant that such products do not provide similar performance. It has also been communicated that the processing of lead crystal glass further allows creating items of higher complexity in this respect.

31.8 Recommendation

The justification for the renewal of Ex. 29 is based on the observation that alternatives for EEE articles with lead crystal glass do not meet the technical criteria representing the specific optical properties. If these properties can be judged as indispensable, then an exemption would be considered to be justified, as possible (substance) substitutes for lead in glass currently do not allow manufacturing comparable articles and would also result in a higher consumption of energy and other resources. Such alternatives would not compare in terms of optical properties and complexity of design should they be manufactured with lead-free glass. Using lead-free alternatives in the actual handcrafted manufacture stages of LCG would not allow completing all manufacture stages at sufficient quality, while also resulting in an additional impact in terms of energy consumption and resource use. In this case, other EEE articles fulfilling similar functions (e.g., a luminaire which functions in providing light) would not be considered as one-toone replacements and thus also not as alternatives. On this basis, it is recommended to grant the exemption renewal for the maximum duration according to Article 5(2), as information suggests that a period of at least 10 years could be needed before substitutes may become available. In this case, the following formulation and duration would be recommended for the exemption.

Exemption n. 29	Duration*	
Lead bound in crystal glass as defined in Directive	For Cat. 1-10: 21 July 2021	
69/493/EEC	For Sub-Cat. 8 in-vitro: 21 July 2023**	
	For Sub-Cat. industrial: 21 July 2024**	

Note: *As it can be understood that the exemption duration may vary for various categories on the basis of Article 5(2), expiration dates have been specified here for all categories either on the basis of the requested duration in the exemption request which the consultants perceive to be justified, or on the basis of the validity periods specified in Article 5(2) for categories, which are newly in scope.

** In contrast, the applicants have not specified the exemption to be relevant for EEE of categories 8 and 9, and in the consultants view it would be recommended to align the exemption duration for all EEE, including Sub. Cat. in-vitro and Sub-Cat. 9 industrial, should EEE in these categories make use of the exemption despite lacking evidence thereof.

31.9 References Exemption 29

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APPENDICES

A.1.0 Appendix 1: Relevant REACH Regulation Entries

Relevant annexes and processes related to the REACH Regulation have been crosschecked to clarify:

- In what cases granting an exemption could "weaken the environmental and health protection afforded by Regulation (EC) No 1907/2006" (Article 5(1)(a), pg.1)
- Where processes related to the REACH regulation should be followed to understand where such cases may become relevant in the future;

The last consolidated version has been consulted in this respect, published on 2 February 2016. Compiled information in this respect has been included, with short clarifications where relevant, in the following tables: Table A. 1 lists those substances appearing in Annex XIV, subject to Authorisation, which are relevant to the RoHS substances dealt with in the requests evaluated in this project. As can be seen, at present, exemptions have not been granted for the use of these substances.

Designation of the substance, of the	Transitional a	Exempted (categories	
group of substances, or of the mixture	Latest application date (1)	Sunset date (2)	of) uses
4. Bis(2-ethylhexyl) phthalate (DEHP) EC No: 204-211-0 CAS No: 117-81-7	21 August 2013	21 February 2015	Uses in the immediate packaging of medicinal products covered under Regulation (EC) No 726/2004, Directive 2001/82/EC, and/or Directive 2001/83/EC.
5. Benzyl butyl phthalate (BBP) EC No: 201-622-7 CAS No: 85-68-7	21 August 2013	21 February 2015	Uses in the immediate packaging of medicinal products covered under Regulation (EC) No 726/2004, Directive 2001/82/EC, and/or Directive 2001/83/EC.
6. Dibutyl phthalate (DBP) EC No: 201-557-4 CAS No: 84-74-2	21 August 2013	21 February 2015	Uses in the immediate packaging of medicinal products covered under Regulation (EC) No 726/2004, Directive 2001/82/EC, and/or Directive 2001/83/EC.
7. Diisobutyl phthalate (DIBP) EC No: 201-553-2 CAS No: 84-69-5	21 August 2013	21 February 2015	
10. Lead chromate EC No: 231-846-0	21 Nov 2013	21 May 2015	-

Table A. 1: Relevant Entries from Annex XIV: The List of Substances Subject to Authorization

Designation of the substance, of the	Transitional arrangements		Exempted (categories
group of substances, or of the mixture	Latest application date (1)	Sunset date (2)	of) uses
CAS No: 7758-97-6			
11. Lead sulfochromate yellow (C.I. Pigment Yellow 34) EC No: 215-693-7 CAS No: 1344-37-2	21 Nov 2013	21 May 2015	-
red (C.I. Pigment Red 104) EC No: 235-759-9 CAS No: 12656-85-8	21 Nov 2013	21 May 2015	-
16. Chromium trioxide EC No: 215-607-8 CAS No: 1333-82-0	21 Mar 2016	21 Sep 2017	-
17. Acids generated from chromium trioxide and their oligomers Group containing: Chromic acid EC No: 231-801-5 CAS No: 7738-94-5 Dichromic acid EC No: 236-881-5 CAS No: 13530-68-2 Oligomers of chromic acid and dichromic acid EC No: not yet assigned CAS No: not yet assigned	21 Mar 2016	21 Sep 2017	-
18. Sodium dichromate EC No: 234-190-3 CAS No: 7789-12-0 10588-01-9	21 Mar 2016	21 Sep 2017	-
19. Potassium dichromate EC No: 231-906-6 CAS No: 7778-50-9	21 Mar 2016	21 Sep 2017	-
20. Ammonium dichromate EC No: 232-143-1 CAS No: 7789-09-5	21 Mar 2016	21 Sep 2017	-
21. Potassium chromate EC No: 232-140-5 CAS No: 7789-00-6	21 Mar 2016	21 Sep 2017	
22. Sodium chromate EC No: 231-889-5 CAS No: 7775-11-3	21 Mar 2016	21 Sep 2017	
28. Dichromium tris(-chromate) EC No: 246-356-2 CAS No: 24613-89-6	22. July 2017	22 January 2019	
29. Strontium chromate EC No: 232-142-6 CAS No: 7789-06-2	22 July 2017	22 January 2019	
30. Potassium hydroxyoctaoxodizincatedichromate EC No: 234-329-8 CAS No: 11103-86-9	22 July 2017	22 January 2019	
31. Pentazinc chromate octahydroxide EC No: 256-418-0 CAS No: 49663-84-5	22 July 2017	22 January 2019	

For the substances currently restricted according to RoHS Annex II: cadmium, hexavalent chromium, lead, mercury, polybrominated biphenyls and polybrominated diphenyl ethers and their compounds, we have found that some relevant entries are listed in Annex XVII of the REACH Regulation. The conditions of restriction are presented in Table A. 2 below. Additionally, some amendments have been decided upon, and are still to be included in the concise version. These may be seen in Table A. 3.

Designation of the substance, of the group of substances or of the mixture	Conditions of restriction
8. Polybromobiphenyls; Polybrominatedbiphenyls (PBB) CAS No 59536-65-1	 Shall not be used in textile articles, such as garments, undergarments and linen, intended to come into contact with the skin. Articles not complying with paragraph 1 shall not be placed on the market.
 16. Lead carbonates: (a) Neutral anhydrous carbonate (PbCO 3) CAS No 598-63-0 EC No 209-943-4 (b) Trilead-bis(carbonate)- dihydroxide 2Pb CO 3 -Pb(OH) 2 CAS No 1319-46-6 EC No 215-290-6 	Shall not be placed on the market, or used, as substances or in mixtures, where the substance or mixture is intended for use as paint. However, Member States may, in accordance with the provisions of International Labour Organization (ILO) Convention 13, permit the use on their territory of the substance or mixture for the restoration and maintenance of works of art and historic buildings and their interiors, as well as the placing on the market for such use. Where a Member State makes use of this derogation, it shall inform the Commission thereof.
17. Lead sulphates: (a) PbSO 4 CAS No 7446-14-2 EC No 231-198-9 (b) Pb x SO 4 CAS No 15739-80-7 EC No 239-831-0	Shall not be placed on the market, or used, as substances or in mixtures, where the substance or mixture is intended for use as paint. However, Member States may, in accordance with the provisions of International Labour Organization (ILO) Convention 13, permit the use on their territory of the substance or mixture for the restoration and maintenance of works of art and historic buildings and their interiors, as well as the placing on the market for such use. Where a Member State makes use of this derogation, it shall inform the Commission thereof.
18. Mercury compounds	 Shall not be placed on the market, or used, as substances or in mixtures where the substance or mixture is intended for use: (a) to prevent the fouling by micro-organisms, plants or animals of: the hulls of boats, cages, floats, nets and any other appliances or equipment used for fish or shellfish farming, any totally or partly submerged appliances or equipment; (b) in the preservation of wood; (c) in the impregnation of heavy-duty industrial textiles and yarn intended for their manufacture; (d) in the treatment of industrial waters, irrespective of their use.
18a. Mercury CAS No 7439-97-6 EC No 231-106-7	 Shall not be placed on the market: (a) in fever thermometers; (b) in other measuring devices intended for sale to the general public (such as manometers, barometers, sphygmomanometers, thermometers other than fever thermometers). The restriction in paragraph 1 shall not apply to measuring devices that were in use in the Community before 3 April 2009. However Member States may restrict or prohibit the placing on the market of such measuring devices.

Table A. 2: Conditions of Restriction in REACH Annex XVII for RoHSSubstances and Compounds

Designation of the substance, of the group of substances or of the mixture	Conditions of restriction
	3. The restriction in paragraph 1(b) shall not apply to:
	(a) measuring devices more than 50 years old on 3 October 2007;(b) barometers (except barometers within point (a)) until 3 October 2009.
	5. The following mercury-containing measuring devices intended for industrial and professional uses shall not be placed on the market after 10 April 2014:
	 (a) barometers; (b) hygrometers; (c) manometers; (d) sphygmomanometers;
	(e) strain gauges to be used with plethysmographs;(f) tensiometers;
	(g) thermometers and other non-electrical thermometric applications. The restriction shall also apply to measuring devices under points (a) to (g) which are placed on the market empty if intended to be filled with mercury.
	6. The restriction in paragraph 5 shall not apply to:
	 (a) sphygmomanometers to be used: (i) in epidemiological studies which are ongoing on 10 October 2012; (ii) as reference standards in clinical validation studies of mercury-free sphygmomanometers; (b) thermometers exclusively intended to perform tests according to standards
	that require the use of mercury thermometers until 10 October 2017; (c) mercury triple point cells which are used for the calibration of platinum resistance thermometers.
	7. The following mercury-using measuring devices intended for professional and industrial uses shall not be placed on the market after 10 April 2014:
	 (a) mercury pycnometers; (b) mercury metering devices for determination of the softening point. 8. The restrictions in paragraphs 5 and 7 shall not apply to:
	 (a) measuring devices more than 50 years old on 3 October 2007; (b) measuring devices which are to be displayed in public exhibitions for cultural and historical purposes.
	For the purpose of this entry, the codes and chapters indicated in square brackets are the codes and chapters of the tariff and statistical nomenclature of Common Customs Tariff as established by Council Regulation (EEC) No 2658/87 (1).
	1. Shall not be used in mixtures and articles produced from the following synthetic organic polymers (hereafter referred to as plastic material):
	— polymers or copolymers of vinyl chloride (PVC) [3904 10] [3904 21] — polymethane (PLIR) [3009 50]
23. Cadmium and its compounds CAS No 7440-43-9	 polydictinatic (Fore) [3707 30] low-density polyethylene (LDPE), with the exception of low-density polyethylene used for the production of coloured masterbatch [3901 10] cellulose acetate (CA) [3912 11]
FC No 231-152-8	collulose acetate buturate (CAP) [2012 11]
	- cellulose acetate butylate (CAB) [3912 11]
	— epuny resiris [3707 30] — malamina formaldahuda (ME) resins [2000 20]
	- inclamine-formal denyde (ivii) resins [3909 20] - urea-formal denyde (IIE) resins [3909 10]
	— unsaturated polyesters (LIP) [3907 91]
	— polvethylene terephthalate (PET) [3907 60]
	— polybutylene terephthalate (PBT)
	- transparent/general-purpose polystyrene [3903 11]
	— acrylonitrile methylmethacrylate (AMMA)

Designation of the substance, of the group of substances or of the mixture	Conditions of restriction
	cross-linked polyethylene (VPE)
	— high-impact polystyrene
	— polypropylene (PP) [3902 10]
	Mixtures and articles produced from plastic material as listed above shall not be placed on the market if the concentration of cadmium (expressed as Cd metal) is equal to or greater than 0,01 % by weight of the plastic material.
	By way of derogation, the second subparagraph shall not apply to articles placed on the market before 10 December 2011.
	The first and second subparagraphs apply without prejudice to Council Directive 94/62/EC (13) and acts adopted on its basis.
	By 19 November 2012, in accordance with Article 69, the Commission shall ask the European Chemicals Agency to prepare a dossier conforming to the requirements of Annex XV in order to assess whether the use of cadmium and its compounds in plastic material, other than that listed in subparagraph 1, should be restricted.
	2. Shall not be used in paints [3208] [3209].
	For paints with a zinc content exceeding 10 % by weight of the paint, the concentration of cadmium (expressed as Cd metal) shall not be equal to or greater than 0,1 % by weight.
	Painted articles shall not be placed on the market if the concentration of cadmium (expressed as Cd metal) is equal to or greater than 0,1 % by weight of the paint on the painted article.
	3. By way of derogation, paragraphs 1 and 2 shall not apply to articles coloured with mixtures containing cadmium for safety reasons.
	4. By way of derogation, paragraph 1, second subparagraph shall not apply to:
	 mixtures produced from PVC waste, hereinafter referred to as 'recovered PVC',
	 mixtures and articles containing recovered PVC if their concentration of cadmium (expressed as Cd metal) does not exceed 0,1 % by weight of the plastic material in the following rigid PVC applications:
	(a) profiles and rigid sheets for building applications:
	(b) doors, windows, shutters, walls, blinds, fences, and roof gutters;
	(c) decks and terraces; (d) cable ducts:
	(e) pipes for non-drinking water if the recovered PVC is used in the middle layer of a multilayer pipe and is entirely covered with a layer of newly produced PVC in compliance with paragraph 1 above.
	Suppliers shall ensure, before the placing on the market of mixtures and articles containing recovered PVC for the first time, that these are visibly, legibly and indelibly marked as follows: ' <i>Contains recovered PVC</i> ' or with the following pictogram:
	In accordance with Article 69 of this Regulation, the derogation granted in paragraph 4 will be reviewed, in particular with a view to reducing the limit

Designation of the substance, of the group of substances or of the mixture	Conditions of restriction
mixture	value for cadmium and to reassess the derogation for the applications listed in
	points (a) to (e), by 31 December 2017.
	5. For the purpose of this entry, 'cadmium plating' means any deposit or coating of metallic cadmium on a metallic surface.
	Shall not be used for cadmium plating metallic articles or components of the articles used in the following sectors/applications:
	(a) equipment and machinery for:
	— food production [8210] [8417 20] [8419 81] [8421 11] [8421 22] [8422] [8435] [8437] [8438] [8476 11]
	— agriculture [8419 31] [8424 81] [8432] [8433] [8434] [8436]
	— cooling and freezing [8418]
	— printing and book-binding [8440] [8442] [8443]
	(b) equipment and machinery for the production of:
	— household goods [7321] [8421 12] [8450] [8509] [8516]
	— furniture [8465] [8466] [9401] [9402] [9403] [9404]
	— sanitary ware [7324]
	— central heating and air conditioning plant [7322] [8403] [8404] [8415]
	In any case, whatever their use or intended final purpose, the placing on the market of cadmium-plated articles or components of such articles used in the sectors/applications listed in points (a) and (b) above and of articles manufactured in the sectors listed in point (b) above is prohibited.
	6. The provisions referred to in paragraph 5 shall also be applicable to cadmium- plated articles or components of such articles when used in the sectors/applications listed in points (a) and (b) below and to articles manufactured in the sectors listed in (b) below:
	(a) equipment and machinery for the production of:
	— paper and board [8419 32] [8439] [8441] textiles and clothing [8444] [8445] [8447] [8448] [8449] [8451] [8452]
	(b) equipment and machinery for the production of:
	 industrial handling equipment and machinery [8425] [8426] [8427] [8428] [8429] [8430] [8431]
	- road and agricultural vehicles [chapter 87]
	— rolling stock [chapter 86]
	– vessels [chapter 89]
	7. However, the restrictions in paragraphs 5 and 6 shall not apply to:
	 — articles and components of the articles used in the aeronautical, aerospace, mining, offshore and nuclear sectors whose applications require high safety standards and in safety devices in road and agricultural vehicles, rolling stock and vessels,
	— electrical contacts in any sector of use, where that is necessary to ensure the reliability required of the apparatus on which they are installed.
	8. Shall not be used in brazing fillers in concentration equal to or greater than 0,01 % by weight.
	Brazing fillers shall not be placed on the market if the concentration of cadmium (expressed as Cd metal) is equal to or greater than 0,01 % by weight.
	For the purpose of this paragraph brazing shall mean a joining technique using alloys and undertaken at temperatures above 450 $^\circ\mathrm{C}.$
	 By way of derogation, paragraph 8 shall not apply to brazing fillers used in defence and aerospace applications and to brazing fillers used for safety reasons.
	10. Shall not be used or placed on the market if the concentration is equal to or

Designation of the substance, of the group of substances or of the mixture	Conditions of restriction
	 greater than 0,01 % by weight of the metal in: (i) metal beads and other metal components for jewellery making; (ii) metal parts of jewellery and imitation jewellery articles and hair accessories, including: bracelets, necklaces and rings, piercing jewellery, wrist-watches and wrist-wear, brooches and cufflinks. 11. By way of derogation, paragraph 10 shall not apply to articles placed on the market before 10 December 2011 and jewellery more than 50 years old on 10 December 2011.
28. Substances which appear in Part 3 of Annex VI to Regulation (EC) No 1272/2008 classified as carcinogen category 1A or 1B (Table 3.1) or carcinogen category 1 or 2 (Table 3.2) and listed as follows: — Carcinogen category 1A (Table 3.1)/carcinogen category 1 (Table 3.2) listed in Appendix 1 — Carcinogen category 1B (Table 3.1)/carcinogen category 2 (Table 3.2) listed in Appendix 2: Chromium (VI) trioxide Zinc chromates including zinc potassium chromate Nickel chromate Nickel dichromate Nickel dichromate Potassium dichromate Sodium dichromate Chromyl dichloride; chromic oxychloride Potassium chromate Chromium (VI) compounds, with the exception of barium chromate and of compounds specified elsewhere in Annex VI to Regulation (EC) No 1272/2008 Chromium III chromate; chromic chromate Sodium chromate Cadmium chloride Cadmium chloride Cadmium chloride	 Without prejudice to the other parts of this Annex the following shall apply to entries 28 to 30: 1. Shall not be placed on the market, or used, as substances, as constituents of other substances, or, in mixtures, for supply to the general public when the individual concentration in the substance or mixture is equal to or greater than: either the relevant specific concentration limit specified in Part 3 of Annex VI to Regulation (EC) No 1272/2008, or, the relevant generic concentration limit specified in Part 3 of Annex I of Regulation (EC) No 1272/2008. Without prejudice to the implementation of other Community provisions relating to the classification, packaging and labelling of substances and mixtures, suppliers shall ensure before the placing on the market that the packaging of such substances and mixtures is marked visibly, legibly and indelibly as follows: By way of derogation, paragraph 1 shall not apply to: (a) medicinal or veterinary products as defined by Directive 2001/82/EC and Directive 2001/83/EC; (b) cosmetic products and oil products: motor fuels which are covered by Directive 98/70/EC, mineral oil products intended for use as fuel in mobile or fixed combustion plants, fuels sold in closed systems (e.g. liquid gas bottles); (d) artist' paints covered by Regulation (EC) No 1272/2008; (e) the substances listed in Appendix 11, column 1, for the applications or uses listed in Appendix 11, column 2. Where a date is specified in column 2 of Appendix 11, the derogation shall apply until the said date.

Conditions of restriction

Designation of the substance, of the group of substances or of the mixture	Conditions of restriction
 Reproductive toxicant category 1B adverse effects on sexual function and fertility or on development (Table 3.1) or reproductive toxicant category 2 with R60 (May impair fertility) or R61 (May cause harm to the unborn child) (Table 3.2) listed in Appendix 6: Bis(2-ethylhexyl) phthalate; di-(2-ethylhexyl) phthalate; DEHP Benzyl butyl phthalate; DBP Dibutyl phthalate Cadmium fluoride Cadmium fluoride Cadmium Sulphate Potassium dichromate Sodium chromate Sodium chromate Sodium chromate Nickel dichromate Lead compounds with the exception of those specified elsewhere in this Annex Lead acetate Lead alkyls Lead azide Lead chromate Lead chromate Lead chromate Lead hydrogen arsenate Lead styphnate Lead (II) methane- sulphonate Trilead bis- (orthophosphate) Lead nickel salt 	
47. Chromium VI compounds	 Cement and cement-containing mixtures shall not be placed on the market, or used, if they contain, when hydrated, more than 2 mg/kg (0,0002 %) soluble chromium VI of the total dry weight of the cement. If reducing agents are used, then without prejudice to the application of other Community provisions on the classification, packaging and labelling of substances and mixtures, suppliers shall ensure before the placing on the market that the packaging of cement or cement-containing mixtures is visibly, legibly and indelibly marked with information on the packing date, as well as on the storage conditions and the storage period appropriate to maintaining the activity of the reducing agent and to keeping the content of soluble chromium VI below the limit indicated in paragraph 1. By way of derogation, paragraphs 1 and 2 shall not apply to the placing on the market for, and use in, controlled closed and totally automated processes in which cement and cement-containing mixtures are handled solely by machines

Designation of the substance, of the group of substances or of the mixture	Conditions of restriction
	 and in which there is no possibility of contact with the skin. 4. The standard adopted by the European Committee for Standardization (CEN) for testing the water-soluble chromium (VI) content of cement and cement-containing mixtures shall be used as the test method for demonstrating conformity with paragraph 1. 5. Leather articles coming into contact with the skin shall not be placed on the market where they contain chromium VI in concentrations equal to or greater than 3 mg/kg (0,0003 % by weight) of the total dry weight of the leather. 6. Articles containing leather parts coming into contact with the skin shall not be placed on the market where any of those leather parts contains chromium VI in concentrations equal to or greater than 3 mg/kg (0,0003 % by weight) of the total dry weight of the leather. 7. Paragraphs 5 and 6 shall not apply to the placing on the market of second-hand articles which were in end-use in the Union before 1 May 2015.
51. The following phthalates (or other CAS and EC numbers covering the substance): (a) Bis (2-ethylhexyl) phthalate (DEHP) CAS No 117-81-7 EC No 204-211-0 (b) Dibutyl phthalate (DBP) CAS No 84-74-2 EC No 201-557-4 (c) Benzyl butyl phthalate (BBP) CAS No 85-68-7 EC No 201-622-7	 Shall not be used as substances or in mixtures, in concentrations greater than 0,1 % by weight of the plasticised material, in toys and childcare articles. Toys and childcare articles containing these phthalates in a concentration greater than 0,1 % by weight of the plasticised material shall not be placed on the market. For the purpose of this entry 'childcare article' shall mean any product intended to facilitate sleep, relaxation, hygiene, the feeding of children or sucking on the part of children.
63. Lead and its compounds CAS No 7439-92-1 EC No 231-100- 4	 Shall not be placed on the market or used in any individual part of jewellery articles if the concentration of lead (expressed as metal) in such a part is equal to or greater than 0,05 % by weight. For the purposes of paragraph 1: (i) 'jewellery articles' shall include jewellery and imitation jewellery articles and hair accessories, including:

Designation of the substance, of the group of substances or of the mixture	Conditions of restriction
	on the market for the first time before 9 October 2013 and jewellery articles articles produced before 10 December 1961.
	6. By 9 October 2017, the Commission shall re-evaluate paragraphs 1 to 5 of this entry in the light of new scientific information, including the availability of alternatives and the migration of lead from the articles referred to in paragraph 1 and, if appropriate, modify this entry accordingly.
	7. Shall not be placed on the market or used in articles supplied to the general public, if the concentration of lead (expressed as metal) in those articles or accessible parts thereof is equal to or greater than 0,05 % by weight, and those articles or accessible parts thereof may, during normal or reasonably foreseeable conditions of use, be placed in the mouth by children. That limit shall not apply where it can be demonstrated that the rate of lead release from such an article or any such accessible part of an article, whether coated or uncoated, does not exceed 0,05 μ g/cm 2 per hour (equivalent to 0,05 μ g/g/h), and, for coated articles, that the coating is sufficient to ensure that this release
	foreseeable conditions of use of the article. For the purposes of this paragraph, it is considered that an article or accessible part of an article may be placed in the mouth by children if it is smaller than 5 cm in one dimension or has a detachable or protruding part of that size.
	8. By way of derogation, paragraph 7 shall not apply to:
	 (a) jewellery articles covered by paragraph 1; (b) crystal glass as defined in Annex I (categories 1, 2, 3 and 4) to Directive 69/493/ EEC;
	(c) non-synthetic or reconstructed precious and semi-precious stones (CN code 7103 as established by Regulation (EEC) No 2658/87) unless they have been treated with lead or its compounds or mixtures containing these substances;
	 (d) enamels, defined as vitrifiable mixtures resulting from the fusion, vitrification or sintering of mineral melted at a temperature of at least 500 ° C; (e) keys and locks, including padlocks;
	 (f) musical instruments; (g) articles and parts of articles comprising brass alloys, if the concentration of lead (expressed as metal) in the brass alloy does not exceed 0,5 % by weight; (h) the tips of writing instruments (i) ratigious articles;
	 (i) religious articles; (j) portable zinc-carbon batteries and button cell batteries; (k) articles within the scope of: (i) Directive 94/62/EC; (ii) Regulation (EC) No 1935/2004; (iii) Directive 2009/48/EC of the European Parliament and of the Council (**); (iv) Directive 2011/65/EU of the European Parliament and of the Council (***)
	9. By 1 July 2019, the Commission shall re-evaluate paragraphs 7 and 8(e), (f), (i) and (j) of this entry in the light of new scientific information, including the availability of alternatives and the migration of lead from the articles referred to in paragraph 7, including the requirement on coating integrity, and, if appropriate, modify this entry accordingly.
	10. By way of derogation paragraph 7 shall not apply to articles placed on the market for the first time before 1 June 2016.
	(*) OJ L 326, 29.12.1969, p. 36.
	(**) Directive 2009/48/EC of the European Parliament and of the Council of 18 June 2009 on the safety of toys (OJ L 170, 30.6.2009, p. 1).
	June 2011 on the restriction of the use of certain hazardous substances in electrical and ellectric n n i c e q u i p m e n t (OJL174, 1.7.2011, p. 88).

Table A. 3: Summary of Relevant Amendments to Annexes Not Updated in the Last Concise Version of the REACH Regulation

Designation of the substance, of the group of substances, or of the mixture	Conditions of restriction	Amended Annex	Amendment date
Addition of Entry 62 concerning: (a) Phenylmercury acetate EC No: 200-532-5 CAS No: 62-38-4 (b) Phenylmercury propionate EC No: 203-094-3 CAS No: 103-27-5 (c) Phenylmercury 2-ethylhexanoate EC No: 236-326-7 CAS No: 13302-00-6 (d) Phenylmercury octanoate EC No: - CAS No: 13864-38-5 (e) Phenylmercury neodecanoate EC No: 247-783-7 CAS No: 26545-49-3	 Shall not be manufactured, placed on the market or used as substances or in mixtures after 10 October 2017 if the concentration of mercury in the mixtures is equal to or greater than 0,01% by weight. Articles or any parts thereof containing one or more of these substances shall not be placed on the market after 10 October 2017 if the concentration of mercury in the articles or any part thereof is equal to or greater than 0,01% by weight.' 	Annex XVII, entry 62	20 Sep 2012

As of 28 September 2015, the REACH Regulation Candidate list includes those substances relevant for RoHS listed in Table A. 4 (i.e., proceedings concerning the addition of these substances to the Authorisation list (Annex XIV) have begun and shall be followed by the evaluation team to determine possible discrepancies with future requests of exemption from RoHS (new exemptions, renewals and revocations))¹⁹⁵⁷:

Table A. 4: Summary of Relevant Substances Currently on the REACHCandidate List

Substance Name	EC No.	CAS No.	Date of Inclusion	Reason for inclusion
Cadmium fluoride	232-222-0	7790-79-6	17 December 2014	Carcinogenic (Article 57 a); Mutagenic (Article 57 b); Toxic for reproduction (Article 57 c); Equivalent level of concern having probable serious effects to human health (Article 57 f)
Cadmium sulphate	233-331-6	10124-36-4 31119-53-6	17 December 2014	Carcinogenic (Article 57 a); Mutagenic (Article 57 b); Toxic for reproduction (Article 57 c); Equivalent level of concern having probable serious effects to human health (Article 57 f)
Cadmium chloride	233-296-7	10108-64-2	16 June 2014	Carcinogenic (Article 57a);

¹⁹⁵⁷ Updated according to <u>http://echa.europa.eu/web/guest/candidate-list-table</u>

Substance Name	EC No.	CAS No.	Date of	Reason for inclusion
			Inclusion	Correinogonia (Articla EZa)
Cadmium sulphide	215-147-8	1306-23-6	16 Dec 2013	Equivalent level of concern having probable serious effects to human health (Article 57 f)
Lead di(acetate)	206-104-4	301-04-2	16 Dec 2013	Toxic for reproduction (Article 57 c);
Cadmium	231-152-8	7440-43-9	20 Jun 2013	Carcinogenic (Article 57a); Equivalent level of concern having probable serious effects to human health (Article 57 f)
Cadmium oxide	215-146-2	1306-19-0	20 Jun 2013	Carcinogenic (Article 57a); Equivalent level of concern having probable serious effects to human health (Article 57 f)
Pyrochlore, antimony lead yellow	232-382-1	8012-00-8	19 Dec 2012	Toxic for reproduction (Article 57 c)
Lead bis(tetrafluoroborate)	237-486-0	13814-96-5	19 Dec 2012	Toxic for reproduction (Article 57 c)
Lead dinitrate	233-245-9	10099-74-8	19 Dec 2012	Toxic for reproduction (Article 57 c)
Silicic acid, lead salt	234-363-3	11120-22-2	19 Dec 2012	Toxic for reproduction (Article 57 c)
Lead titanium zirconium oxide	235-727-4	12626-81-2	19 Dec 2012	Toxic for reproduction (Article 57 c)
Lead monoxide (lead oxide)	215-267-0	1317-36-8	19 Dec 2012	Toxic for reproduction (Article 57 c)
Silicic acid ($H_2Si_2O_5$), barium salt (1:1), lead-doped [with lead (Pb) content above the applicable generic concentration limit for 'toxicity for reproduction' Repr. 1A (CLP) or category 1 (DSD); the substance is a member of the group entry of lead compounds, with index number 082-001-00-6 in Regulation (EC) No 1272/2008]	272-271-5	68784-75-8	19 Dec 2012	Toxic for reproduction (Article 57 c)
Trilead bis(carbonate)dihydroxide	215-290-6	1319-46-6	19 Dec 2012	Toxic for reproduction (Article 57 c)
Lead oxide sulfate	234-853-7	12036-76-9	19 Dec 2012	Toxic for reproduction (Article 57 c)
Lead titanium trioxide	235-038-9	12060-00-3	19 Dec 2012	Toxic for reproduction (Article 57 c)
Acetic acid, lead salt, basic	257-175-3	51404-69-4	19 Dec 2012	Toxic for reproduction (Article 57 c)
[Phthalato(2-)]dioxotrilead	273-688-5	69011-06-9	19 Dec 2012	Toxic for reproduction (Article 57 c)
Tetralead trioxide sulphate	235-380-9	12202-17-4	19 Dec 2012	Toxic for reproduction (Article 57 c)
Dioxobis(stearato)trilead	235-702-8	12578-12-0	19 Dec 2012	Toxic for reproduction (Article 57 c)
Tetraethyllead	201-075-4	78-00-2	19 Dec 2012	Toxic for reproduction (Article 57 c)
Pentalead tetraoxide sulphate	235-067-7	12065-90-6	19 Dec 2012	Toxic for reproduction (Article 57 c)
Trilead dioxide phosphonate	235-252-2	12141-20-7	19 Dec 2012	Toxic for reproduction (Article 57 c)
Orange lead (lead tetroxide)	215-235-6	1314-41-6	19 Dec 2012	Toxic for reproduction (Article 57

Substance Name	EC No.	CAS No.	Date of	Reason for inclusion
			Inclusion	2
				C) Toxic for reproduction (Article 57
Sulfurous acid, lead salt, dibasic	263-467-1	62229-08-7	19 Dec 2012	c)
Lead cyanamidate	244-073-9	20837-86-9	19 Dec 2012	Toxic for reproduction (Article 57 c)
Lead(II) bis(methanesulfonate)	401-750-5	17570-76-2	18 Jun 2012	Toxic for reproduction (Article 57 c)
Lead diazide, Lead azide	236-542-1	13424-46-9	19 Dec 2011	Toxic for reproduction (article 57 c),
Lead dipicrate	229-335-2	6477-64-1	19 Dec 2011	Toxic for reproduction (article 57 c)
Dichromium tris(chromate)	246-356-2	24613-89-6	19 Dec 2011	Carcinogenic (article 57 a)
Pentazinc chromate octahydroxide	256-418-0	49663-84-5	19 Dec 2011	Carcinogenic (article 57 a)
Potassium hydroxyoctaoxodizincatedichromate	234-329-8	11103-86-9	19 Dec 2011	Carcinogenic (article 57 a)
Lead styphnate	239-290-0	15245-44-0	19 Dec 2011	Toxic for reproduction (article 57 c)
Trilead diarsenate	222-979-5	3687-31-8	19 Dec 2011	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Strontium chromate	232-142-6	7789-06-2	20 Jun 2011	Carcinogenic (article 57a)
Acids generated from chromium trioxide and their oligomers. Names of the acids and their oligomers: Chromic acid, Dichromic acid, Oligomers of chromic acid and dichromic acid.	231-801-5, 236-881-5	7738-94-5, 13530-68-2	15 Dec 2010	Carcinogenic (article 57a)
Chromium trioxide	215-607-8	1333-82-0	15 Dec 2010	Carcinogenic and mutagenic (articles 57 a and 57 b)
Potassium dichromate	231-906-6	7778-50-9	18 Jun 2010	Carcinogenic, mutagenic and toxic for reproduction (articles 57 a, 57 b and 57 c)
Ammonium dichromate	232-143-1	7789-09-5	18 Jun 2010	Carcinogenic, mutagenic and toxic for reproducetion (articles 57 a, 57 b and 57 c)
Sodium chromate	231-889-5	7775-11-3	18 Jun 2010	Carcinogenic, mutagenic and toxic for reproduction (articles 57 a, 57 b and 57 c)
Potassium chromate	232-140-5	7789-00-6	18 Jun 2010	Carcinogenic and mutagenic (articles 57 a and 57 b).
Lead sulfochromate yellow (C.I. Pigment Yellow 34)	215-693-7	1344-37-2	13 Jan 2010	Carcinogenic and toxic for reproduction (articles 57 a and 57 c))
Lead chromate molybdate sulphate red (C.I. Pigment Red 104)	235-759-9	12656-85-8	13 Jan 2010	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Lead chromate	231-846-0	7758-97-6	13 Jan 2010	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Lead hydrogen arsenate	232-064-2	7784-40-9	28 Oct 2008	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Sodium dichromate	234-190-3	7789-12-0, 10588-01-9	28 Oct 2008	Carcinogenic, mutagenic and toxic for reproduction (articles 57a, 57b and 57c)

Additionally, Member States can register intentions to propose restrictions or to classify substances as SVHC. The first step is to announce such an intention. Once the respective dossier is submitted, it is reviewed and it is decided if the restriction or authorisation process should be further pursued or if the intention should be withdrawn.

As at the time of writing (Fall 2015), it cannot yet be foreseen how these procedures will conclude. It is thus not yet possible to determine if the protection afforded by REACH Regulation would in these cases consequently be weakened by approving the exemption requests dealt with in this report. For this reason, the implications of these decisions have not been considered in the review of the exemption requests dealt with in this report. However for the sake of future reviews, the latest authorisation or restriction process results shall be followed and carefully considered where relevant.¹⁹⁵⁸

As for registries of intentions to identify substances as SVHC, as of 28 September 2015, Sweden has submitted intentions regarding the classification of cadmium fluoride and cadmium sulphate as CMR, intending to submit dossiers in August 2014.None of the current registries of intentions to propose restrictions apply to RoHs regulated substances.¹⁹⁵⁹

As for prior registrations of intention, dossiers have been submitted for the substances listed in Table A. 5.

Restriction / SVHC Classification	Substance Name	Submission Date	Submitted by	Comments
	Cadmium and its compounds	17 Jan 2014	Sweden	Artist paints
Restriction	Cadmium and its compounds	17 Oct 2013	ECHA	Amendment of the current restriction (entry 23) on use of paints with TARIC codes [3208] & [3209] containing cadmium and cadmium compounds to include placing on the market of such paints and a concentration limit.
	Lead and lead compounds	mpounds 18 Jan 2013 Sweden		Placing on the market of consumer articles containing Lead and its compounds
	Chromium VI	20 Jan 2012	Denmark	Placing on the market of leather articles containing

Table A. 5: Summary of Substances for which a Dossier has been submitted, following the initial registration of intention

¹⁹⁵⁸ European Chemicals Agency (ECHA), Registry of intentions to propose restrictions: <u>http://echa.europa.eu/registry-of-current-restriction-proposal-intentions/-</u> /substance/1402/search/+/term (28.09.2015)

[/]substance/1402/search/+/term (28.09.2015) ¹⁹⁵⁹ ECHA website, accessed 28.09.2015: <u>http://echa.europa.eu/web/guest/addressing-chemicals-of-</u> concern/registry-of-intentions

Restriction / SVHC Classification	Substance Name	Submission Date	Submitted by	Comments
				Chromium VI
	Phenylmercuric octanoate; Phenylmercury propionate; Phenylmercury 2-ethylhexanoate; Phenylmercury acetate; Phenylmercury	15 Jun 2010	Norway	Mercury compounds
	Mercury in measuring devices	15 Jun 2010	ECHA	Mercury compounds
	Lead and its compounds in jewellery	15 Apr 2010	France	Substances containing lead
	Cadmium chloride	03 Feb 2014	Sweden	CMR; other;
	Cadmium sulphide	05 Aug 2013	Sweden	CMR; other;
	Lead di(acetate)	05 Aug 2013	Netherlands	CMR
	Cadmium Cadmium oxide	04 Feb 2013 04 Feb 2013	Sweden Sweden	CMR; other; Substances containing Cd CMR; other; Substances Containing Cd
SVHC Classification	Trilead dioxide Phosphonate; Lead Monoxide (Lead Oxide); Trilead bis(carbonate)di- hydroxide; Lead Dinitrate; Lead Oxide Sulphate; Acetic acid, lead salt, basic; Dioxobis(stearato)trilead; Lead bis(tetrafluoroborate); Tetraethyllead; Pentalead tetraoxide sulphate; Lead cyanamidate; Lead titanium trioxide; Silicic acid (H ₂ Si ₂ O ₅), barium salt (1:1), lead-doped; Silicic acid, lead salt; Sulfurous acid, lead salt, dibasic; Tetralead trioxide sulphate; [Phthalato(2-)]dioxotrilead; Orange lead (lead tetroxide); Fatty acids, C16-18, lead salts; Lead titanium zirconium oxide	30 Aug 2012	ECHA	CMR; substances Containing Lead
	Lead(II) bis(methanesulfonate)	30 Jan 2012	Netherlands	CMR; Amides
	Lead styphnate; Lead diazide; Lead azide; Lead dipicrate	01 Aug 2011	ECHA	CMR; Substances containing lead
	Trilead diarsenate			CMR; Arsenic compounds
	Strontium Chromate	24 Jan 2011	France	CMR; Substances containing chromate
	Acids generated from chromium trioxide and their oligomers: Chromic acid; Dichromic acid; Oligomers of chromic acid and dichromic acid	27 Aug 2010	Germany	CMR; Substances containing chromate
	Chromium Trioxide	02 Aug 2010	Germany	CMR; Substances containing chromate
	Sodium chromate; Potassium chromate; Potassium Dichromate	10 Feb 2010	France	CMR; Substances containing chromate

Restriction / SVHC Classification	Substance Name	Submission Date	Submitted by	Comments
	Lead chromate molybdate sulfate red (C.I. Pigment Red 104); Lead sulfochromate yellow (C.I. Pigment Yellow 34)	03 Aug 2009	France	CMR; substances Containing Lead
	Lead Chromate	03 Aug 2009	France	CMR; Substances containing chromate
	Lead hydrogen arsenate	27 Jun 2008	Norway	CMR; Arsenic compounds
	Sodium dichromate	26 Jun 2008	France	CMR; Substances containing chromate

Concerning the above mentioned processes, as at present, it cannot be foreseen if, or when, new restrictions or identification as SVHC might be implemented as a result of this proposal; its implications have not been considered in the review of the exemption requests dealt with in this report. In future reviews, however, on-going research into restriction and identification as SVHC processes and the results of on-going proceedings shall be followed and carefully considered where relevant.

A.4.0 Appendix 4: Exemption 6b

Figure A - 34-1: Material Data Sheet for Al Alloy 6026 provided by EURAL, 1st Page

6026 by EURAL	Lead	Fr	'ee		Ş		R	1	
Colour code EU orange	P	6		G	iNU	דדנ		S.p). A
	Unit: mm							•	
According to EU directives: 2000/53/EC (ELV) – 2011/85/EU (R	oHS II) Extruded	6 + 76,2 30 + 254	12	+ 65 + 165	Thic	k. 12 + 5 c. 30 + 15	5	12 + 6 _	60
	PRESENTATION This innovative alloy h laboratories, in order t environment. It is parti- It has good resistance for decorative and ind Eural 6026 alloy does and cracking of the m Due to its brittle nature significant previous de It can replace 2007, 2 6033, 6040, 6041, 604	as been col o meet the i colarly suita to corrosio ustrial hard not contain achined part e, tin has the formation (s 011, 2015, 2 42, 6061, 60	nceived an most recen able for bei n, medium- anodizing. tin (Sn) wh ts when su e dangerou strain). 2028, 2030 065, 6082,	d develo t standa ng mach high me It is also tich, as i bmitted is tender , 2044, 6 8262, 60	ped in E rds for th ined on i chanical used for t has been to stress noy to su 3012, 60 64A, 620	ural Gn he prote- high spe propert r hot for en prove and hig dden br 12A, 60 52A, 63	utti SpA ction of i eed auto ties, goo ging pur ed, caus jh tempe rakes wit 20, 6021 51, 7020	's reset the ormatic I d suita poses. es wea erature. thout 1, 6023 0 alloys	arch lathe bility aknes 0, 602
	screws, bolts, nuts, th	readed parts Sample	ive industry s. s of finished	y, electri	made of	Eural ba	rs	, not io	. 8 4
Properties Machinability Protective anodizing Decorative anodizing Hard anodizing Resistance to atmospheric corrosion MIG-TIG weldability At resistance weldability Brazing weldability Plastic formability when cold Plastic formability when hot Legend Excellent Good	Acceptable Notrecommer	allohot Sample	s of finished	r, electric products	and ele	Eural ba			11 B
Properties Machinability Protective anodizing Decorative anodizing Hard anodizing Resistance to atmospheric corrosion MIG-TIG weldability MiG-TIG weldability Plastic formability when cold Plastic formability when hot Legend Excellent Good Chemical composition Si 0,60 + 1,40	Acceptable Not recommended	tites	s of finished	y, electric products	made of Me	Eural ba	rs		
Properties Machinability Protective anodizing Decorative anodizing Hard anodizing Resistance to atmospheric corrosion MIG-TIG weldability Brazing weldability Plastic formability when cold Plastic formability when cold Plastic formability when cold Excellent Good Chemical composition Si 0,60 ± 1,40 Fe ≤ 0,70 Out 0.20 ± 0.50	screws, bolts, nuts, th	tites	2.72	products	made of Me Temper	Eural ba Eural ba schanica Rma 370	rs a propert Rp 0.2 300		HE
Properties Machinability Protective anodizing Decorative anodizing Hard anodizing Resistance to atmospheric corrosion Resistance to marine corrosion MiG-TIG weldability Plastic formability when cold Plastic formability when cold Plastic formability when cold Excellent Good Chemical composition Si 0,60 + 1.40 Fe ≤ 0,70 Cu 0,20 + 0,50 Mn 0,20 ÷ 1,00	Acceptable Not recommended property Modulus of elasticity	readed parts Sample Sample ded kg ded kg dm ²	2,72 69.000	products	made of Me Temper T6 T8 '	ectronic Eural base echanicas RPa 370 400	rs I propert Rp 0.2 MPa 300 370	10 10 10 10 10 10 10 10 10 10 10 10 10 1	HE 9
Properties Machinability Protective anodizing Decorative anodizing Hard anodizing Resistance to atmospheric corrosion MIG-TIG weldability Prastic formability when cold Plastic formability when hot Legend Excellent Si 0,60 + 1,40 Fe ≤ 0,70 Cu 0,20 + 1,00 Mg 0,60 + 1,20 Cr ≤ 0,30	screws, bolts, nuts, th	readed particular standard s	2,72 09.000 23,4	products	made of made of made of made of made of made of the ma	Eural ba Eural ba kehanica Rma 370 400 370	75 1 properti Rp 0,2 MPa 300 370 300	ties A% 8 10 8	HE 9
Properties Machinability Protective anodizing Hard anodizing Hard anodizing Hard anodizing Resistance to atmospheric corrosion Resistance to marine corrosion MIG-TIG widelability At resistance weldability Plastic formability when cold Plastic formability when cold Excellent Good Chemical composition Si 0,60 + 1,40 Fe $\leq 0,70$ Cu 0,20 + 0,50 Mn 0,60 + 1,20 Cr $\leq 0,30$ Ni Ni	Acceptable Not recommer Acceptable Not recommer Physical prope Density Modulus of elasticity Coefficient of thermal expansion	A added parts readed parts Sample Sample Classified and the sample Classified and the sample Classified and the sample Readed parts Sample Classified and the sample Classified and the sample Classifi	2,72 69,000 23,4	Extrated	made of made of Me Temper T6 T6 * T6 T6 *	Eural be Eural be schanica Rm MPa 370 400 370 390	rs rs I propert Rp 0,2 300 370 300 350	5000 100 100 100 100 100 100 100 100 100	HE 9
$\begin{tabular}{ c c c c } \hline Properties & \\ \hline Machinability & \\ \hline Protective anodizing & \\ \hline Decorative anodizing & \\ \hline Hard anodizing & \\ \hline Resistance to marine corrosion & \\ \hline MiG-TIG weldability & \\ \hline At resistance weldability & \\ \hline Plastic formability when cold & \\ \hline Plastic formability when cold & \\ \hline Plastic formability when hot & \\ \hline Legend & & \\ \hline \hline & & \\ \hline & &$	Screws, bolts, nuts, th	readed parts Sample	2,72 69,000 23,4 172	Extructed Extructed	Me Temper T6 T6 * T8 T8 T8 T8	echanica schanica MPa 370 400 370 380 345	rs rs I propert Rpp02 RPa 300 370 300 350 315	10 8 10 4 4 10	HE 9 11 9
$\begin{tabular}{ c c c c c } \hline Properties & & & & & & & & & & & & & & & & & & &$	screws, bolts, nuts, th	readed parts readed parts Sample Sample Sample Kg did WPa Kg Kg m ² Kg m ² Kg m ² Kg m ² Kg m ² Kg m ² Kg m ² Kg m ² Kg Kg Kg Kg Kg Kg Kg Kg Kg Kg	2,72 69.000 23,4 172 0,039	presen	made of made of made of made of made of the second	Eural ba Eural ba schanica Rma 370 400 370 390 345 370 320	rs rs rs rs rs rs rs rs rs rs	10 4 10 4	HE 9 111 9 110 110 110 110 110 110 110 110
$\begin{tabular}{ c c c c c } \hline Properties & \\ \hline Machinability & \\ \hline Protective anodizing & \\ \hline Protective anodizing & \\ \hline Hard anodizing & \\ \hline Resistance to marine corrosion & \\ \hline MiG-TIG velidability & \\ \hline At resistance to marine corrosion & \\ \hline MiG-TIG velidability & \\ \hline Prazing welidability & \\ \hline Prazin$	screws, bolts, nuts, th	A mm ³ A mm ³ B A Markov A Mark	2,72 69,000 23,4 172 0,039	Drawn Extrudied	Me Temper T6 T6* T8 T8* T8 T8* T9 T9*	Eural base Eural base schanica RmPa 370 400 370 380 400 400	rs rs rs rs rs rs rs rs rs rs rs rs rs r	5 mot 10	HE 9 111 9 10 9

Figure A - 34-2: Material Data Sheet for AI Alloy 6026 provided by EURAL, 2nd Page

6026 Lead Free

by EURAL

According to RoHS II, ELV, REACH directives

actual and future revisions

Application fields

L is extremely versatile, due to its medium-high mechanical properties, good attitude to anodizing, good weldability, good attitude to forging, good corrosion resistance. 6028 by EURAL is suitable for components used in several industries as automotive, electric and electronic, valves, oleohydraulic, pneumatic, defence.



Ecological choice

Since many years, the European Community is working on reducing the content of hazardous substances. Actual revisions of RoHS, ELV, REACH directives limit the content of Pb to max 0,40% on aluminium alloys, and the tendency for the future is to revise this limit to be lead free.

Eural Gnutti has anticipated the future restrictions of such directives creating the 6026 by EURAL Lead Free.



Aluminium with technology

The born of 6026 by EURAL 6028 by EURAL is an innovative alloy designed and developed by Eural Gnutti S.p.A. R&D laboratories in order to meet the strictest requirements in critical automotive applications such as brake systems.

High machinability

by EURAL is particularly suitable for being machined on high speed automatic lathes due to extremely good chip forming.



Production program

is available in drawn or extruded conditions.

Drawn round bars from 7,94 to 76,2 mm (0,236"-3"), temper T6, T8 or T9.

Extruded round bars from 30 to 254 mm (1,181"-10"), temper T6. Square, rectangular, hexagonal bars are

available. A wide range of drawn bars are also available

in h9 tolerance.

No tin

On many alloys of 6000 series lead (Pb) has been replaced with tin (Sn) which, as it has been proved, causes weakness and cracking of the machined parts when submitted to stress and high temperature (>140°C. 284°F).

Due to its brittle nature, tin has the dangerous tendency to sudden brakes without significant previous deformation (strain).

8026 by EURAL does not contain tin.



Alternative to:

8026 by EURAL is the best alternative to several aluminium alloys such as 2007, 2011, 2015, 2028, 2030, 2044, 6012, 6012A, 6020, 6021, 6023, 6028, 6033, 6040, 6041, 6042, 6061, 6065, 6082, 6262, 6064A, 6262A, 6351, 7020.

026 by EURAL is an excellent replacement of brass, due to its good machinability, good attitude to forging, medium-high mechanical properties. Moreover, since (has a specific gravity of 1/3 compared to brass, it results extremely convenient costwise.

Ultrasonic tested billets

All semi-finished products in 6026 by EURAL are made of 100% ultrasonic tested billets according to SAE AMS-STD-2154 class A.



Compatibility in drawings

was born on 2002, and it has been registered to the Aluminum Association and to EN standards with a lead content of Pb ≤ 0.40.

JRAL lead free therefore does not need any variations in drawings where 6026 is already indicated.

Figure A - 34-3: Technical Laboratory Report of EURAL GNUTTE SpA. on the Manufacture of Brake Pistons

	SnA	M 1203.03	3 Rev. 00	Pag. 1 di 6
EURAL GNUT IT SPA. Rovato			16/02/96	N* 3009
TECHNICAL LABORATORY REPORT (Chilloc		PATORIO
TECHNICAL LABORATORY REPORT /	APPORTO TE	CNICC	DILABO	RATURIO
CUSTOMER/ CLIENTE: Eural Gnu	itti Spa	F	Report No Rapporto nº	<mark>3009</mark>
			Date/In data: 1	4/01/2015
Subject: Brake pistons made of drawn round bars Ø23 mm completely machined, in alloy 6026 lead free T9 belonging to batch 1510150027 (confirm 487127/01 cast 1536H15) and anodized. Two samples have been identified by #1 and #2	oggetto: Pistoncini per frei meccanica di barr 6026 senza pion produzione 15101 1536H15), e anodi Due campioni sono	ni realizz e tonde 1bo T9, 50027 (co zzati. o stati ide	zati mediante Ø23 mm, tra appartenenti onferma 4871	lavorazione filate in lega al lotto di 27/01, colata
Kind of analysis required by customer: Check the pistons made of 6026 lead free	Tipo di analisi richiesi Verifica pistoncini p	e dal clien prodotti c	ite: :on 6026 senz	a piombo
CONCLUSIONS: The analyzed samples have been made of bars in subject.	CONCLUSIONI: I campioni analizi oggetto.	zati sono	o stati ricavati	da barre in
The visual inspection, chemical composition test, hardness test and macrographical test did not emphasize anomalies.	Al controllo visivo durezza e al cont riscontrate anoma	, della co trollo ma lie.	omposizione c crografico no	himica, della n sono state
The micrographical test performed on the samples emphasizes that:	Al controllo micro stato riscontrato d	ografico he:	eseguito sui	campioni è
 The samples have oxide layer with thickness between 13 and 18 µm 	 i campioni hann compresi tra 13 e 	io spessi e 18 µm	ore dell'ossid	o con valori
 The samples have a good distribution of the low-melting element type Bi 	 i campioni ha dell'elemento bas 	anno ur ssofonde	na buona ente tipo Bi	distribuzione
 Oxide microhardness test emphasizes values between 424 and 435 HV 	 Al controllo del stati riscontrati va 	la micro alori com	durezza dell' presi tra 424 e	e 435 HV.

Made/Compilato Brunch	Date/Data	15/02/2016
Verified/Verificato functions long	Date/Data	15/02/2016
Approved/Approvato	Date/Data	15/02/2016

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SURFACE APPEARANCE (see following ASPETTO SUPERFICIALE (vedi fotografie):												
Brake pistons made of machining and anodizing of bars Pistoncini per freni ottenuti mediante lavorazione meccanica ed anodizzazione di barre												
DIMEN	SIONS m	m (see p	pictures)	/DIMEN	SIONI m	ım (vec	li fotograf	ie):				
Require	ed/ Richi	esto: 23	+0/-0.13									
Found/	Riscontr	ato:										
1) 22.16	6÷22.17											
2) 22.16	6÷22.17											
Sample Mr	6:	Fo	CH CH	IEMICA		(SIS /A	NALISI CI	HIMICA	%:	Db	D:	- En
n°camp.	51	re	Cu	MIN	мg	Zn		ur	NI	PD	Ы	Sn
nin 🕴	0.600	0.700	0.200	0.200	0.600	0.300	0.000	0.300		0.400	0.500	0.050
<u>∉</u> æ мax 1	0977	0.588	0.409	0.660	0.789	0.071	0.020	0.073		0.01	5 1.22	1 0.001
2	0.981	0.593	0.413	0.660	0.794	0.070	0.020	0.073		0.01	5 1.29	7 0.001
Remole	D	MEC	HANICA	L PROP	ERTIES	/ CAR/	ATTERIST	ICHE M	ECCANIC	HE:	Dealtion	of hardness
No Nº camp.	MPa		dp₀.₂ MPa	A	R	ec.	Strizione		Durezza		Schema della	urement a di rillevo durezza
1		_	_					-	116	_		
2									116			
Macrog	raphs (s	ee follov	ving pict	tures)	co	М	acrografie	e (vedi f	otografie)		
Etchi	ng: NaOr	1 20% SO	nution a	(50°C X	60 sec.		Attacco N	aOH 20	% a 50°C	per 6	u secono	
1,2) No defect. Structure with fine and 1,2) Nessun difetto. Struttura a grano fine ed												
							-					
Microhardness oxyde / Mirodurezza ossido (HV)												
				Zone/ Zona								
	sample/ campione		A	а в с		с	D			-		
1		424	43	35 4	435	435						
2		435	43	35 4	435	424						
	L		1									
									С			

Made/Compilato	Buic	Date/Data	15/02/2016
Verified/Verificato	profess long	Date/Data	15/02/2016

EURAL GNUTTI SpA.....

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PICTURES OF SAMPLE AS DELIVERED BY THE CUSTOMER FOTOGRAFIE DEL CAMPIONE COME CONSEGNATOCI DAL CLIENTE



Samples #1 and #2 as Campioni n°1 e n°2 come delivered by the customer consegnatici dai cliente.

MACROGRAPHICAL PICTURES MADE ON THE SAMPLES MACROGRAFIE ESEGUITE SUI CAMPIONI



Macrograph: Etching: NaOH 20%a 50°C per 60 sec. Transversal section Macrografia: Attacco: NaOH 20% a 50°C per 60 sec Sezione trasversale

Made/Compilato	Date/Data	15/02/2016
Verified/Verificato fragens long	Date/Data	15/02/2016

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MICROGRAPHICAL PICTURES PERFORMED ON SAMPLE No 1 MICROGRAFIE ESEGUITE SUL CAMPIONE N°1



Micrograph X100 Etching: Not etched Transversal section Micrografia X100 Attacco: Non attaccato Sezione trasversale. Micrograph X500 Etching: Not etched Transversal section Oxide layer: 15÷18 µm

Micrografia X500 Attacco: Non attaccato Sezione trasversale. Spessore dell'ossido: 15÷18µm

MICROGRAPHICAL PICTURES PERFORMED ON SAMPLE No 2 MICROGRAFIE ESEGUITE SUL CAMPIONE N°2



Micrograph X100 Etching: Not etched Transversal section Micrografia X100 Attacco: Non attaccato Sezione trasversale. Micrograph X500 Etching: Not etched Transversal section Oxide layer: 13÷18 µm Micrografia X500 Attacco: Non attaccato Sezione trasversale. Spessore dell'ossido: 13÷18µm

Made/Compilato	Build	Date/Data	15/02/2016
Verified/Verificato	profess long	Date/Data	15/02/2016
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MICROGRAPHICAL PICTURES PERFORMED ON SAMPLE No 1 MICROGRAFIE ESEGUITE SUL CAMPIONE N°1

MICROGRAPHICAL PICTURES PERFORMED ON SAMPLE No 2 MICROGRAFIE ESEGUITE SUL CAMPIONE N°2



Made/Compilato	5 miles	Date/Data	15/02/2016
Verified/Verificato	refere lang	Date/Data	15/02/2016

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MICROGRAPHICAL PICTURES PERFORMED ON SAMPLE No 1 MICROGRAFIE ESEGUITE SUL CAMPIONE N°1

MICROGRAPHICAL PICTURES PERFORMED ON TRANSVERSAL SECTION OF SAMPLE #1 MICROGRAFIE ESEGUITE SULLA SEZIONE TRASVERSALE DEL CAMPIONE N°1



Micrograph X100. Etching: n°1 per 10 sec. Cortical zone Micrografia X100. Attacco: nº1 per 10 sec. Zona corticale

Made/Compilato	Frence	Date/Data	15/02/2016
Verified/Verificato	profess long	Date/Data	15/02/2016

A.7.0 Appendix 7: Cd-based Ink Printing Colours that do not Exist in Cadmium-Free Versions (Ex. 21)

Lists of specific hues submitted by IRL and HGT are both copied below in light of small differences:

Source: HGT (2016a), Hecker Glass Technik, Answers to 1st round of clarification questions, submitted per email 18.1.2016

1002	sandyellow	2000	yelloworange	3000	firered	4007	purpleviolet
1003	signalyellow	2001	redorange	3001	signalred	6010	grasgreen
1004	goldyellow	2002	bloodorange	3002	chimney red	8012	redbrown
1007	narcissusyellow	2003	pastel orange	3003	ruby red		•
1017	saffron yellow	2004	orange	3004	purple red		•
1021	rape yellow	2008	lightredorange	3005	wine red		
1023	traffic yellow	2009	trafficorange	3007	blackred		
1027	curry yellow	2010	signalorange	3009	Oxired		
1028	melone yellow	2011	darkorange	3011	brownred		
1032	broom yellow	2012	pollack orange	3012	beigered		
1034	pastel vellow			3013	tomato red		•
1037	Sunvellow			3014	old pink		
				3016	coral red		
				3018	strawberry red		
				3020	traffic red		
	•		•	3022	pollack red		•
				3031	orientred		

Source: IRL (2016a), Irlbacher Blickpunkt Glas GmbH, Answers to 1st round of clarification questions, submitted per email 18.1.2016

1002	sandyellow	2000	yelloworange	3000	firered	4007	purpleviolet
1003	signalvellow	2001	redorange	3001	signalred	6010	arasareen
1004	aoldvollow	2002	bloodorango	2002	chimnov rod	8012	rodbrown
1004	goldyellow	2002	bioodorange	0002	chininey red	0012	reabiowin
1007	narcissusyellow	2003	pastel orange	3003	ruby red		
1017	saffron yellow	2004	orange	3004	purple red		
1021	rape yellow	2008	lightredorange	3005	wine red		
1023	traffic yellow	2009	trafficorange	3007	blackred		
1027	curry yellow	2010	signalorange	3009	Oxired		
1028	melone yellow	2011	darkorange	3011	brownred		
1032	broom yellow	2012	pollack orange	3012	beigered		1
1034	pastel yellow			3013	tomato red		
1037	Sunyellow			3014	old pink		
				3016	coral red		
				3018	strawberry red		
				3020	traffic red		
				3022	pollack red		

A.8.0 Appendix 8: Leaching Test Results Related to Ex. 29

Test results sent on 26.6.2015 to by EDG to the European Commission, related to the possible leaching of lead from lead crystal.

Stazione Venezia - Mura ^{Venezia - Marghera,}	Sperimentale del Vetro S.c.p.A. no, Via Briati 10 Via delle Industrie 13 - cio VEGA Edificio Pegaso		
	RAPPORTO DI PROVA / TEST REPORT N.	126760	pag. 1 di 1
Murano	23/04/2015 rif. Yr/mail of confirmation	on dated 11.03.2015	
richiedente proposer	FEDERATION DES CRISTALLERIES - VERRERIES - 112-114 RUE LA BOETIE - 75008 PARIS	A LA MAIN ET MIXTE	
c <i>ampione</i> sample	GLASS	<i>prova eseguita dal /</i> from test date <i>al /</i> to	30/03/2015 2/04/2015
contrassegnato reference	CRYSTAL GLASS CHANDELIER Sampling performed by the client		
ricevuto il received	18/03/2015 by carrier		

UNI EN 12457-2: 2004 (Charaterization of waste : Leaching- Compliance test for leaching of granular waste materials and sludges Part2: One stage batch test at liquid to solid ratio of 10 L/kg for materials with particle size below 4 mm without or with size reduction)

Principle

A sample of glass cullet was crushed and sieved to a grain size between 0.5 and 4 mm and then immersed in water with a liquid to solid ratio of 10 L/kg for 24 h at room temperature $(20^{\circ}C \pm 5^{\circ}C)$ under agitation. A fler this treatment the eluate was filtered and analysed using the ENV 12506:2004 and ENV 13370:2004 methods and others.

Results:

Parameters:		
pН	Start	8.8
	End	9.8
Temperature (°C)		22.0
Conductivity (µS/cm)	Start	3.4
	End	18.0

	Method of liquid solid s	eparation:	filtering over 0.45 µm membrane
0	Mass of test portion	(kg)	0.090
£	Volume of leachant	(1)	0.900
	Moisture content (% w	/w)	< 0.10

Costituents		Limit of determination (mg/l)	Blank (mg/l)	Eluate concentration (mg/l)	Amount leached (mg/kg)
Arsenic,	As	0.002	< 0.002	0.003	0.03
Cadmium,	Cd	0.0002	< 0.0002	< 0.0002	< 0.002
Chromium,	Cr	0.002	< 0.002	< 0.002	< 0.02
Lead,	Pb	0.002	< 0.002	0.249	2.49
Selenium,	Se	0.002	< 0.002	0.0043	0.043
Antimony,	Sb	0.002	< 0.002	0.060	0.600

Test carried out at Murano Laboratories

THE ANALYST	THE LABORATORIES DIRECTOR
Dr.ssa Martina Scarpa	Dr. Nicola Favaro
Le prove repartiel se queste response cal fondere la testere ** have campione agente de malair active data alla richadiene presente le canava la campione company de la canavaria data della seconda	decreditate de ACCREDIA ** non visorenno nell'Accreditamento ACCREDIC el questo Laboratorio. Se atorna che il inicide supra visoretate. Il presente attornato si riforiare al compiune cuminato quest può ensore riprudotto parzialmente.
The tests indicated in this report which are cited as ** Non Accreditate da AC proverts the above-mentioned characteristics. This Test Report is relevant excl the law.	CREDIA ** do not fall under ACCREDIA Accreditation. We declare that the analysed sample, provided by the customer, usively for the speciment tested and it consist be partially reproduced. Issued on unstamped paper for the use: foreseen by
Mod. PG5-06 REV. 7 02.5.2013	

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-	SSV	

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EVALUATION OF THE GLASS SAMPLE

104410			
Sa	m	pl	le
1.777		***	

Crystal Glass obtained from two different pieces of a Chandelier: arm and candle cap

General Classification

Release of Pb on landfill due to leaching of metal from glass after the disposal in landfill Leaching test carried out according to EN 12457-2 and TC13 protocol; comparison with limit values set out in Chapter 2.2 "Criteria for landfills for non-hazardous waste" in Council Decision 2003/33/EC

Constituent	Concentration mg/kg	limit value for non-hazardous waste mg/kg
Pb	2,49	10

Crystal glass: "Glass, oxide, chemicals" (CAS 65997-17-3)

Evaluation

Pb concentration is below the limit values set out in Chapter 2.2 "Criteria for landfills for non-hazardous waste" in Council Decision 2003/33/EC".

Stazione Sperimentale del Vetro S.c.p.A. – The Glass Research Center Via Briati, 10 – 30141 Murano (VE) = P.I. 04176900278 + T.+39 041.2737011 + F.+39 041.2737048 + <u>www.spevetro.it</u> = mail@spevetro.it Sede secondaria: c/o VEGA Edificio Pegaso – Via delle industrie, 13 - 30175 Venezia Marghera = T. +39 041.5383112 + F. +39 041.5090669