Questionnaire for Further Clarification

Exemption Request "Mercury in single capped (compact) fluorescent lamps not exceeding (per burner)"

(questions answered by ELC, 22/06/2012)

Background

The Öko-Institut together with Fraunhofer IZM has been appointed within a framework contract for the evaluation of applications for granting, renewing or revoking an exemption to be included in or deleted from Annexes III and IV of the new RoHS Directive 2011/65/EU (RoHS 2) by the European Commission.

You have submitted the above mentioned request for exemption which has been subject to a first completeness and understandability check. As a result we have identified that there is some information missing and a few questions to clarify before we can proceed with the online stakeholder consultation on your request. Therefore we kindly ask you to provide answers for the following questions and to reformulate your request if necessary.

Questions

1. You mention that long life lamps are used for specific applications.
    a. In which specific applications long life lamps are used?

       The use of Long life lamps is directed to areas where lamp replacement is difficult and expensive due to high ceilings, special luminaire design for critical application requirements or too much disturbance of running processes during long operating hours. Also applications where safety of people is at stake e.g. heavy duty industry halls, chemical industry and oil platforms requiring very reliable long life specifications.

       Electrical characteristics of long life lamps are compatible to normal life lamps. This makes it possible to use long life lamps in both new and existing installations, without further modifications.

b. Please clarify the scope of the exemption request between long life and short life lamps. Could you please provide technical standards or other generally accepted documents to define long life and short life, respectively?

Typically only electrical data are standardized to facilitate exchangeability of lamps. Lifetime data are set by the lamp manufacturers. The lifetime performances of the various single capped lamps do differ strongly per lamp family.

In practice, typically the long life lamps have lifetimes double or triple of the normal lamp types. Commercially lifetime statements for long life lamps per today can be found from 15.000 hours onwards showing some overlap with normal life statements. See Annex 2 for an overview of the lifetime statements claims per today as published on free accessible websites).

Considering applications of single-capped compact fluorescent lamps covering consumer applications (integrated CFL) and professional application (non-integrated CFL), long life single-capped compact lamps have average lifetimes of at least 15.000 hrs in 3h-cycle (165' on/15' off) (ELC position see ROHS FAQ doc on ELC website)

c. Could you please provide a wording for the requested exemption?

Actually the required Mercury levels of 3.5 mg max is required for a wide power range of long life lamps for general lighting. An exemption request is applied for a power range < 30 W for long life time specifications with an average lifetime of at least 20.000 h.

The ELC proposal for the final exemption wording can be found below:

1: Mercury in single capped (compact) fluorescent lamps not exceeding (per burner):

1(a)1: For general lighting purposes < 30 W with normal lifetime:

5 mg expires on 31 December 2011;

3,5 mg may be used per burner after 31 December 2011 until 31 December 2012;

2,5 mg shall be used per burner after 31 December 2012

1(a)2: For general lighting purposes < 30 W with longer lifetime (≥ 20.000):

3.5 mg after 31 December 2012

2. Could you please elaborate more detailed the difference between the quantity of 3.5 mg and 2.5 mg mercury? Why is the requirement of max. 3.5 mg mercury more practicable?

   a. Early lifetime failures:

      Single-capped compact fluorescent lamps start failing due to a lack of luminous flux caused by mercury depletion during operation (see Graph 1 in the original exemption request form Dec 2011). Standard lifetime lamps can properly reach their defined lifetime with a dose of max 2.5 mg. Long life lamps require higher mercury dosing to realize the lifetime extension preventing from early failing during operation. In this case a max level of 3.5 mg (+ 40 %) ensures the long life lamp functionality up to 60.000 h.

   b. Average dosing vs. max ROHS levels for long life lamps

      As ROHS Mercury levels are addressing the max allowed dosing values in lamps, the design of the lamp product and lamp processing should assure that no lamp should have a mercury dose higher than the ROHS max level while still achieving its long life specifications and avoiding early failures. To meet ROHS max limits, the average level of mercury content should be lower, depending on the tolerances of dosing technique used (see 2.c). These average or called nominal content values are published by manufacturers in datasheets and public available websites (see Annex 1)

   c. State of technology: Typical test results Mercury consumption

      Lamp manufacturers have performed since many decennia mercury consumption studies to determine the feasibility of reducing the mercury content in lamps (see graph in Annex 4 for the history of EU industry technology status).

      An extended test on mercury consumption for typical long life CFL lamps have been carried out for more than 8 years (>65.000 h) and shown in Annex 5, based on the latest state of lamp design and process technology (graph already shown in the original exemption request form in Dec 2011).

      The study was carried out by life testing of lamps on burning racks more than 65.000 h with a cycle of 3h-cycle (165’ on/15’ off) and measuring the mercury content of lamps at several lifetimes.

      The applied measurement technique for mercury content in lamps is standardized in IEC62554. The individual lamp results are plotted in the graph and an average curve is drawn (see black line).

      An empirical theoretical model has been developed for mercury consumption based on many test results evaluated in last decades. Based on this model, the x axis is

adapted in a non-linear way, resulting in straight lines for mercury consumption vs. lifetime. In the graph, the average trend and maximum mercury consumption line is given (black resp. green line). If requested, The ELC is willing to provide more insight in the technical details of the study on a confidential basis as these studies are part of the competitive edge of companies.

d. Max level setting without jeopardizing lifetime specifications

To avoid mercury depletion during life, the required maximum ROHS dose limit is indicated by the green line in Annex 5.

As stated in the original exemption request, the required statistical tolerance for a solid product design has been calculated using a Design for six sigma (DFSS) approach, a well-known and sound statistical tolerance approach used in many industries.

This approach results in the required dose limit indicated by the green line in the graph (boundary condition on max mercury dosing). In practice this line means that lifetime of lamps will not be jeopardized by too low mercury dose, leading to impracticable early failures due to premature light loss.

Therefore, the required ROHS dose max limit for a solid design is indicated by the green line in Annex 4. Based on this line we propose to use a max level of 3.5 mg mercury for long life lamps with lifetimes more than 20.000 hours. (see area right from red arrow). A max level of 2.5 mg dose can be maintained for lamps with a lifetime below approximately 20.000 hours (see area left from red arrow).

In Annex 1 the current state of technology is summarized, based on a recent website overview published by main EU lamp manufacturers for specified long life lamps in the range of 15.000 - 60.000 h). The published values express the average mercury dose of lamps as also defined in EU Ecodesign / EUP regulation (Note: not the ROHS max levels).

The table shows, based on the current state of technology, that most EU lamp manufacturers publish an average level of 3 – 3.5 mg for long life lamps, which means in practice that the maximum content is even higher (depending on the tolerances of the dosing technology used in the manufacturing processes for lamps and dosing units; estimated for a 6 sigma range ca. 0.5 mg or more above the published average value)

Based on these website publications, the current state of technology for long life lamps does not show the ability to meet the ROHS exemption limit of max 2.5 mg after 31 December 2012 for wattages < 30 W and lifetimes up to 60.000 h.

e. Environmental impact:

Long life lamps are the best option from environmental-, resource- and economical point of view (Mercury use, production effort, materials use, recycling effort, cost). In this case a max level increase from 2.5 to 3.5 mg (+ 40 %) ensures the long life lamp functionality above 20.000 h, realizing more than double or triple the lifetime which is also from a total environmental point view a very positive proposition.

3. Can you provide any evidence on the high lifetime of 60.000 hours of long life lamps? Are there any corresponding test results available in addition to the provided graphs in your exemption? Is there any third party verification on this?

   Long life lamps performing from 15.000 - 60.000 h are published on the internet and proven in the market (see overview, Annex 1). As knowledge on lamp performance is a strong competitive edge of lamp manufacturers, all tests are performed internally and no publicly available studies are published nor performed by other stakeholders. Consequently, these life tests are performed internally. The applied measurement technique for mercury content in lamps is performed by MiPlaza-PINS and and standardized in IEC62554. This is a proven method used by many laboratories and test houses and has been externally verified in a round robin test (as published Jan 2011 on ELC website).

   The long lifetime tests are part of confidential internal company knowledge and testing, and part of companies competitive edge. These tests are confirming that longer lifetimes can be realized if sufficient mercury dose is used (in analogy with fluorescent lamps, see ROHS exemption 2(a)5). It is known that the lifetime of (compact) fluorescent lamps strongly depends on the operating conditions and on the balance of components as mercury. As an example the switching frequency also highly impacts the lifetime (See Annex 3 for the published dependency by some lamp manufacturers).

4. You mention continuous R&D with a view to reducing the mercury content. Please provide evidence on reduction efforts and timeframe.

   The mercury content in fluorescent lamps has been reduced substantially throughout the years (see Ecodesign/EUP regulation). As you can read from Annex 3 thanks to the continuous ongoing R&D efforts the mercury dose in fluorescent lamps reduced in the past 30 years with more than 90%.

5. Please describe more in detail the ongoing evaluation of mercury free fluorescent lamps.

For some limited specific applications dielectric barriers eximer discharges have been applied but not for mainstream general lighting as high efficiency lamps could be obtained: See summary on

http://en.wikipedia.org/wiki/Dielectric_barrier_discharge

An external publication on mercury free discharges can be found in: Haverlag; Journal of Physics D: Applied Physics, Vol. 40(2007), No. 13, p. E01-E01,

6. Please provide detailed technical evidence why there is no LED-technology-based alternative as LEDs are known to have a high efficiency as well as a very long lifetime.

As described in Question 1, long life lamps can be applied on both new and existing installations. LED lamps for existing single-capped lamp applications are becoming available in the market; but for existing installations the efficacy levels typically are lower than for fluorescent (long life) lamps. Moreover, many LED lamps create directional light. As the luminaire is designed for a specific light distribution of the fluorescent lamp and as the lamp orientation in luminaires for single-capped lamps varies in the market a full retrofit LED lamp solution is not yet widely available or affordable for lamp replacement in many existing luminaires.

7. If you want to use socio-economic arguments for the duration of the requested exemption, please provide detailed figures to support your argumentation.

The limited availability of mercury free alternatives (e. g. LED) for existing installations would prevent a simple lamp exchange in existing long life fluorescent applications and luminaires (spare parts). This would imply a refurbishment of all installed installations. Not only from cost perspective, but also from environmental-, resource- and economical point of view this is not a preferred scenario.

In general, increasing life time of lamps is the best option for the environment (Mercury impact, production effort, materials use, recycling effort, cost).

Therefore, long life CFL lamps are preferred to be used and should not phased out from the market and consequently resulting in the refurbishment of all related luminaires in the market.

Main conclusions based on Mercury consumption evaluations:

1. The average mercury consumption is increasing during life time (see linear black line). To assure longer life time's approx. > 20.000 h, an amount of

mercury is required, higher than the ROHS limit of 2.5 mg max after 31 Dec 2012.

2. Most lamp manufacturers still need higher mercury levels in published long life lamps using current state of technology (3.0 – 3.5 mg).
3. To assure the specifications of long life lamps with average lifetimes of approx. 20.000-60.000 h a max level for mercury dose of 3.5 mg is needed to avoid impracticable early failures due to premature light loss (based on life testing study in Annex 5)
4. Therefore a new exemption request for long life lamps is necessary to assure the specifications and reliability of long life CFL lamps.

   As EU lamp manufacturers state and publish long life lamps commercially from 15.000 h onwards (for consumer and professional applications, see Annex 1), the ELC has requested for clarity and practicality reasons (enforcement) an exemption request for 3.5 mg from 15.000-60.000 h was issued in Dec 2011
5. Long life CFL lamps are a better option from environmental-, resource- and economical point of view compared to normal life CFL lamps.

Annex 1: Average Mercury levels of several manufacturers:

Published on company websites for normal life and long life single-capped fluorescent lamps (Remark: max values are higher; N/A = Not Available on published websites)

			Service Life (h) 3 h (2:45+0:15)		10 % Mortality (h) 3 h (2:45+0:15)		10 % Mortality (h) 12 h (11 h+1 h)		Average lifetime (h) (50 % failures) 3 h (2:45+0:15)		Average lifetime (h) (50 % failures) 12 h (11 h+1 h)		10 % Mortality (h) 1 switching - continuous		Hg (mg)
COMPACT FLUORESCENT			conv.[1]	electr.[2]	conv.[1]	electr.[2]	conv.[1]	electr.[2]	conv.[1]	electr.[2]	conv.[1]	electr.[2]	conv.[1]	electr.[2]	
AURA	UNIQUE LL	-D, -D/E (10-26W)	15.000	24.000	-	-	24.000	30.000	-	-	36.000	42.000	-	-	3,0
AURA	UNIQUE LL	-S, -S/E (7-11W)	15.000	24.000	-	-	24.000	30.000	-	-	36.000	42.000	-	-	3,0
AURA	UNIQUE LL	-T (18-26W), -T/E (18-57W)	15.000	24.000	-	-	24.000	30.000	-	-	36.000	42.000	-	-	3,0
AURA	UNIQUE LL	-L (18-36W)	30.000	42.000	-	-	36.000	48.000	40.000	52.000	46.000	57.000	-	-	3,5
AURA	UNIQUE LL	-L (40-80W)	-	42.000	-	-	-	48.000	-	52.000	-	57.000	-	-	3,5
GE	BIAX LONG LAST	-D (10-26W), T (13-42W)	-	-	-	-	-	-	-	-	12.000	-	-	-	<3,0
GE	BIAX LONG LAST	-D/E (10-26W), -T/E (13-42W)	-	-	-	-	-	13.000	-	-	-	20.000	-	-	<3,0
GE	BIAX LONG LAST	-Q/E (57W)	-	-	-	-	-	13.000	-	-	-	20.000	-	-	N/A
GE	BIAX LONG LAST	-L (18-36W)			-	-		-	-	10.000	-	-	-	-	<3,0
GE	BIAX LONG LAST	-L (40-80W)	-	-	-	-	-	13.000	-	20.000	-	22.500	-	-	<3,0
OSRAM	DULUX XT	-D/E (18-26W), -T/E (32-42W)	-	18.000	-	-	-	-	-	36.000	-	-	-	-	N/A
OSRAM	DULUX XT	-L (18-36W)	-	-	-	-	-	-	21.000	36.000	-	-	-	-	N/A
OSRAM	DULUX XT	-L (55W)	-	-	-	-	-	-	-	36.000	-	-	-	-	N/A
PHILIPS	MASTER XTRA PL	-C (18-26W) 2-pin	-	-	12.000	-	-	-	16.000	-	-	-	-	-	3,0
PHILIPS	MASTER XTRA PL	-C (18-26W) 4-pin	-	-	-	20.000	-	-	-	33.000	-	-	-	-	3,0
PHILIPS	MASTER XTRA PL	-T (32-57W) 4-pin	-	-	-	20.000	-	-	-	33.000	-	-	-	-	3,0
PHILIPS	MASTER XTRA PL	-L (24-55W) 4 pin	-	-	14.000	25.000	-	-	21.000	36.000	-	-	-	-	3,0

Data from free accessable web pages of lamp manufacturers - status 2012-02.
1) conventional with starter
2) electronic with HF ballast warm start

Annex 2: Lifetime statements:

Published on company websites for normal life and long life single-capped fluorescent lamps for consumer and professional applications. Lifetime based upon 50% survivals in 3 hours cycle (165 min. on – 15 min. off)

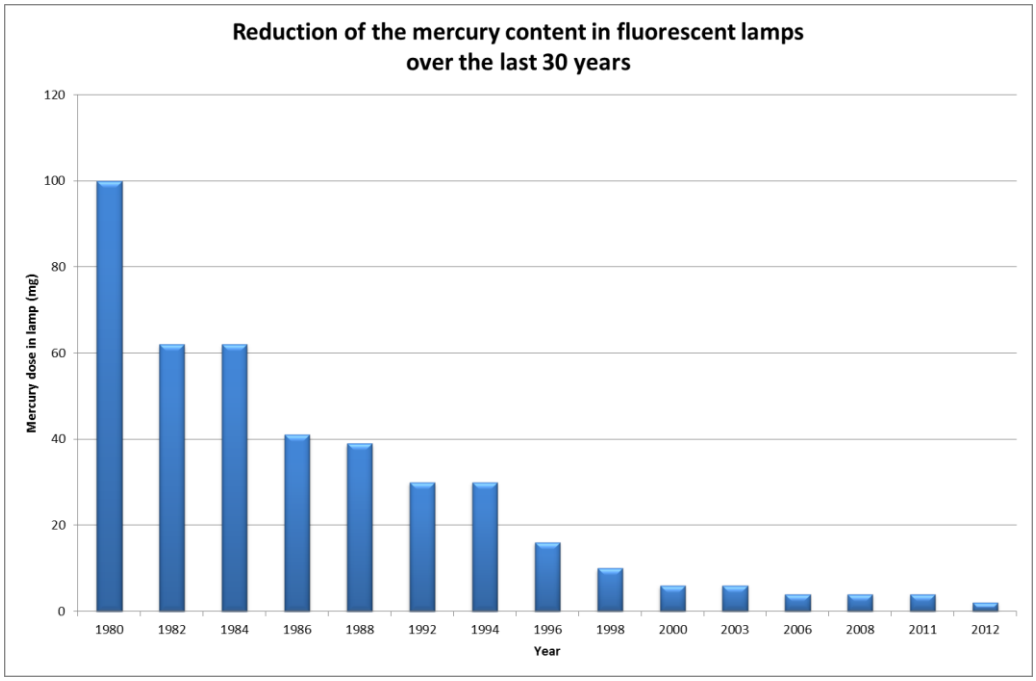
	Normal lamps					Longlife lamps					
Lamp base	Philips	Osram	GE	Sylvania	**average**	Philips	Osram	GE	Aura	**average**	**factor vs normal**
G24d	10	10	12	10	11	16	-	-	15	16	1.5
G24q	13	20	20	12	16	33	36	-	24	31	1.9
2G11 (EM)	15	20	10	15	15	21	36	-	40	32	2.2
2G11(HF)	20	20	20	15	19	36	36	-	52	41	2.2
GX24d	10	10	12	15	12	16	-	-	15	16	1.3
GX24q	13	20	15	15	16	33	36	-	24	31	2.0
					15					29	2.0

Annex 3: Lifetime dependence on operating conditions:

For typical Long life single capped fluorescent lamps (2G11)

cycle	circuit	Philips	Aura
3 hrs cycle	ElectroMagnetic	21	40
	HF- Preheat start	36	52
12 hrs cycle	ElectroMagnetic	39	45
	HF- Preheat start	44	58
24 hrs	ElectroMagnetic	45	-
	HF- Preheat start	47	-

Annex 4: Evaluation of mercury dosed per lamp over the last 30 years (source: ELC)



Annex 5: Evaluation of mercury consumption for Long life CFL lamps

Typical results for 2G11 lamps tested by Philips (tested on burning racks with a cycle of 3h-cycle (165' on/15' off).