Adaptation to scientific and technical progress under Directive 2002/95/EC

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The views expressed in this final report are the sole responsibility of the authors and do not necessarily reflect the views of the European Commission.

The recommendations given by the authors should not be interpreted as a political or legal signal that the Commission intends to take a given action.

[13] ELC reaction with regard to proposed 1 mg limit value for CFL; 18.11.2008 ("ELC reaction EuP 1mg.msg")

[14] Proposal on CCFL & EEFL from JELMA; 19 September 2008 ("Material for the stakeh meeting on 24th Sep.-JELMA.ppt" updated by "2008-10-15 JELMA Proposal for CCFLs.ppt")

[15] EICTA Position on Exemptions 1-4 "Mercury in lamps"; 23 September 2008 ("EICTA Position on Exemption 1-4 23rd September 2008.pdf")

[16] AeA position on exemptions 1-4; 23 September 2008 (e-mail from 23.09.2008 11:31)

[17] LIF Lighting Industry Federation; Technical statement No. 41 "T5 Lamp Adaptors for T8 Luminaires: Do they ensure energy saving and conformance with relevant standards and legislation?"(2007)

4.8 Exemption No. 5

"Lead in glass of cathode ray tubes, electronic components and fluorescent tubes"

4.8.1 General approach

The current exemption covers three fields of applications with quite different requirements. Therefore this exemption will be described in the following sections for each field of application separately.

4.8.1.1 Lead in glass of cathode ray tubes

Due to the basic functionality, in CRT displays electrons are accelerate toward a luminescent material deposited at the front panel. As the decelerating electrons produce radiation, lead as lead oxide is added to the glass matrix in CRTs to act as a shield against radiation. Thus lead as lead-oxide in the glass matrix is used due the ability to absorb gamma rays and other forms of harmful radiation. Furthermore lead oxide is used as sealing frit between funnel, panel and nec glass.

During stakeholder consultation and in the follow-up process, several contributions were received covering this field of application [5], [15], [16]. All of them agree that lead in the cone glass were the only effective method to shield x-rays emanated from the electron beam in CRTs. Only in the front glass barium could be used [5]. This position corresponds to descriptions available in literature.

Basically one could object that meanwhile other display technologies are available, notably LCD and PDP and that therefore substitution at a system level would be feasible. However, there are applications where the specific functionality of CRTs is superior to the new technologies, especially in the case of low and high ambient temperatures [17] as well when fast moving pictures are to be displayed. Therefore substitution at system level is currently not being feasible.

Against this background the consultant recommends to prolong the existing exemption. In this specific case lead is used due a functionality based on fundamental physical properties. It is not imaginable that another material could be found delivering the same function. Therefore there would not be advantages in defining an expiry date. [16]

4.8.1.2 Lead in glass of fluorescent tubes

The existing exemption was granted on request of ELC. ELC formerly claimed that lead containing glass was needed in flares and exhaust tubes for production process reasons.

ELC contributed to the current review as follows [5]: ELC members are in the process of phasing out lead of all lamp glass for most if not all lamps. Lead glass will be substituted by lead-free glass by changing the production process.

Against this background, the current exemption will not be needed further on.

However, Lamp glass producers use recycling glass for the production of new glass in order to save material resources and of course to save energy. According to ELC's contribution energy consumption for glass production is reduced up to 30% by the use of recycling glass [5]. As lamps (and other glasses) in the past did contain lead this substance is also contained in the recycling glass. Unfortunately every single batch of recycling glass is different regarding lead content. In order not to hamper the use of recycling glass a limit slightly higher than current limit of 0,1% wt is necessary, and it is necessary for all lamp glass, not only for fluorescent lamps. It is also necessary to have more legal certainty for manufacturers. From environmental point of view the use of recycling glass reduces energy use, reduces waste to be disposed of. As the use of lead in new glass is decreasing dramatically ELC do not expect to need this "exemption extension" for more than 1 period.

4.8.1.3 Lead in glass of electronic components

In contrast to the application fields of lead in glass mentioned above this field of application comprises a number of various electronic components. Typical examples are lead-based electrodes, resistors, capacitors, chip coils, chip inductors, resistance networks, capacitor networks, hybrid ICs, power semiconductors etc. Furthermore, this kind of electronic components are used for nearly all kind of applications, including the total range of WEEE categories. Therefore the current exemption covers lead-containing glass in different applications with quite different functions and different possibilities for substitution, accordingly.

Some stakeholders that produce rather specific products were able to provide specific data and to reflect the specific conditions of substitution. The specific arguments are summarised below.

4.8.2 Justification by stakeholders

During the review process several stakeholder contributions were provided:

Rosemount Inc. / Emerson Process Management submitted several documents related to three types of applications ([1], [2], [3] – by error, all documents were sent to the reviewers as submissions to exemption 25).

- Lead oxide containing glass in its high performance capacitive metal pressure sensors:
- The applicant points out that the high performance metal capacitive sensors are used as pressure, level and flow instrumentations in various process industries. The PbO-containing glass is used in a glass-to-metal seal within the sensors. Substitution problems are mainly due to safety issues as the replacement of the lead oxide (PbO)-containing glass carries the risk to reduce the reliability and therefore the control of the product. Substitutes would have to show the same or better temperature and pressure stability as PbO-containing glass. Furthermore a specific thermal expansion coefficient and specific flow and adhesion characteristics would have to be matched.
- Lead oxide containing glass in high performance electrochemical pH and ORP sensors:
- Similar to the previously mentioned application the pH and ORP sensors produced by Rosemount are also used in various process industries. The PbO-containing glass is used in a stem glass part which represents the basis of the sensor. According to the applicant the coefficient of thermal expansion, the high electrical resistivity, the high chemical resistance (even at elevated temperatures) as well as a good interference chemistry can currently only be met by PbO-containing glass. Again, the lack of substitutes is due to safety issues as a structural failure in the sensors may result in a loss of control and therefore represents a risk to the equipment, the environment and the personnel.
- Lead oxide containing glass seal frit to hermetically seal the reference chamber of sapphire based pressure sensors:
- According to Rosemount the PbO-containing glass is used in a hermetic seal part with sapphire based pressure sensors. These sensors are applied mainly in hazardous and remote industrial locations and substitution is currently technically and scientifically impracticable. In this type of application the thermal expansion coefficient does not represent a problem for substitutes. However, the vacuum, the firing temperature and the frit material itself, which may attack the metal conductors of the sensors, are the main reasons for a lack of substitutes. As for the previously depicted sensors a PbO-free alternative for sapphire based pressure sensors would at present represent a safety risk to the environment, the equipment and the personnel.

Despite several years of research and continuing efforts no technically feasible substitutes for the PbO-containing glass have been found yet and according to Rosemount no other company currently offers feasible substitutes. Furthermore the amount of lead per year (see data on 2006 and 2007) did not exceed 460 kg within the EU for all three types of sensors according to Rosemount.

Vishay provided information on PbO-containing glass in vitreous enamelled resistors for reliability applications as telecom-protection and on PbO-containing resistive paste in thick film resistors for power applications [4]. Although Vishay spent 1-2 man years on research for substitutes the mechanical and physical characteristics (e.g. dilatation coefficient and high temperature resistance for vitreous enamelled resistors and the ductility as well as the stability for thick film resistors) have not been met. However, Vishay noted that for their application several tonnes of PbO are consumed per year.

In their joint industry contribution **EICTA, AeA Europe, EECA ESIA and ZVEI** support the information provided by Rosemount and Vishay [5]. This contribution agrees with the previous statements that for Pb in glass for electronic components, in glass for protection-hermetic seals as well as in glass in glass frit substitutes are unavailable to date.

Sensata uses Pb-glass in thermal overload devices and therefore emphasizes once again on the safety issue of the material. As Pb-glass in these applications provides a low softening point and at the same time a hermetic sealing it is an essential safety issue for the end-application (e.g. refrigerators) [8].

The Japan Business Council in Europe (**JBCE**) in collaboration with a Japanese ICT Organization (**JEITA**) submitted sound information on the substitution difficulties for Pb-glass in glass frits thick film technology, showing that also climatic conditions pose a problem to the tested substitution materials [9].

In a submission document from **PerkinElmer** [10] the analytical application of Pb-glass in Channel Multipliers (CPM) is also explained as essential because PbO is used in solder-glass for this application. Additionally, **SCHOTT** – who uses solder-glasses for optoelectronic devices – explains the substitution of lead-containing solder-glasses is still unfeasible although several attempts of Pb-free solder glasses have been made [11].

4.8.3 Critical review

Environmental risks:

As the lead is bound within the glass there is no direct health or environmental risk of it in this application because the possibility of release to the environment is greatly reduced. According to some stakeholders there are several applications of Pb-glass in electronic components providing the function of security devices. A substitute of inferior quality might have disastrous consequences to personnel and to the environment in case of failure.

Research for substitution:

As described within several stakeholder contributions (e.g. Sensata [12], Joint industry contributions [5] & [9], SCHOTT [11]) research on substitution for lead in glass of electronic components has been investigated for years and is still to date. However, currently no substitutes are available and even promising substitution materials are missing. For future research it is also important to keep in mind that “alternative material” as bismuth, for example, may even increase the environmental impact and the energy consumption (e.g. as lead is a by-product of the bismuth production).

In summary a future substitute of lead in glass of electronic components would have to meet the following demands:

- match of the thermal expansion coefficient;
- affinity with material;
- electric stability;
- low softening point and low calcination temperature;
- weather, moisture and chemical resistance (e.g. acid resistance).

Wording:

Assuming that the current wording might be too widespread the contractor attempted to narrow the scope of the existing exemption. During the stakeholder meeting (11th June 2008) it was discussed to identify a new wording (for each kind of application) reflecting the different functionality of lead-containing glass. Another suggestion was to provide a component specific wording reflecting the specific functions (like hermetic seal etc.) for each single application, or at least for typical groups of application.

However, it became obvious that the changing of the current wording would be difficult. The challenge with a function specific list for these lead containing components is that first of all less obvious components (as photo multipliers) might be forgotten and second of all – as invention is an ongoing process – new inventions might be hampered by such a specific listing. Additionally, there are some cases where lead in glass provides more than one function. Furthermore a new wording with specific applications might create confusion in the supply chain. Additionally such a list would be quite complex which becomes obvious by regarding the JBCE list of electronic parts which use Pb-glass and which were obtained from a survey of 57 electronic component manufacturers [13][26]. A list of 18 products using Pb-glass components, submitted by the Test and Measurement Coalition [14], also supports this statement.

4.8.4 Recommendation

In order to reflect the different functions and applications and the developments described above we recommend to split up the existing exemption as follows:

- *Lead in glass of cathode ray tubes. (Assuming that each exemption is required to have an expiry date, the consultants propose 31 July 2014 to give the stakeholders opportunities to submit evidence in the next review of the Annex for the further need of this exemption beyond 2014, if appropriate.)*
- *Lead in the glass of fluorescent tubes not exceeding 0,2% by weight. Expiry date: 31 July 2014.*
- *Electrical and electronic components which contain lead in a glass or ceramic other than a dielectric ceramic, or in a glass or ceramic matrix compound (e.g. piezoelectronic devices) until 31 July 2014, and for the repair, and to the reuse, of equipment put on the market before 1 January 2015.* (see section 4.12 in this report)

4.8.5 References

[1] Rosemount submission to exe. 5 “Exemption_25_Emerson_I_26_March_2008.pdf”

[2] Rosemount submission to exe. 5 “Exemption_25_Emerson_II_26_March_2008.pdf”

[3] Rosemount submission to exe. 5 “Exemption_25_Emerson_III_26_March_2008.pdf”

[4] Vishay submission to exe. 5 “Exemption-5-6-7_VishaySA_31_March_2008.pdf”

[5] Joint industry contribution (EICTA, AeA Europe, EECA ESIA and ZVEI) to exe. 5 “Exemption_5_EICTA_and-others_1_April_2008.pdf”

[6] ELC submission to exe. 5 “Exemption-5_European-Lamp-Companies-Federation_31_March_2008.pdf”

[7] ELC submission to exe. 5 “Questions exemptions 5_ELC_2008-06-17 final.pdf”

[8] Sensata submission to exe. 5 “Exemption_5_Sensata_Technologies_31_ March_2008.pdf”

[26] This document has been considered as confidential until an e-mail exchange between Mr. Fasano (JBCE) and Öko-Institut (20.06.2008)

[9] JBCE partially confidential submission to exe. 5 "Exemption-5_JBCE_1_April_2008.pdf"

[10] PerkinElmer submission to exe. 5 " Exemption_5_PerkinElmer_1_April_2008.pdf"

[11] Schott submission to exe. 5 "Comparison of different solder glasses_22.08.2008.pdf"

[12] Sensata submission to exe. 5 "Sensata presentation for Stakeholder Meeting (2).ppt"

[13] JBCE submission to exe. 5 "JBCE_(File No,2)Summary of data Lead glass .pdf"

[14] T&M Coalition email to exe. 5 "TM coalition response to RoHS exe. 5 follow-up_7.08.08.msg"

[15] Pecht, Michael; Review of High-Lead Solder and Lead-Glass RoHS Exemptions. CALCE Electronic Products and Systems Center. University of Maryland. 25/03/2008

[16] HP Letter to the Öko-Institut. June 30, 2008

[17] Jäger, Ralph; Technical information on (1) Black and white CRT for viewfinder of professional-use camera, (2) Color CRT Monitor for professional-use

4.9 Exemption No. 6

"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"

4.9.1 Description of exemption

Lead is used as an alloying element in steels, aluminium and copper. The main effect of lead in these metals is an improved machinability. Lead acts as a lubricant and the addition of lead results in better chip fracturing and surface finish as well as in higher cutting speeds and a longer tool life.

In view of consistency in environmental legislation it should be noted that Annex II to the ELV Directive[27] also includes exemptions for the use of lead up to 0,35% in steel, (entry no. 1), up to 0,4% in aluminium, (entry no. 2) and up to 4% in copper (entry no. 3). Information and data provided in the context of the recent adaptation to scientific and technical progress of ELV Annex II [1] have been taken into account in the present adaptation of the RoHS Directive.

In the following sections the use of lead as an alloying element is discussed separately for each of the three metals steel, aluminium and copper.

[27] Directive 2000/53/EC on end-of-life vehicles (ELV Directive)