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

Final report

Freiburg, 20 February 2009

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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.

[8] Markus Stutz, Dell Inc.; information sent to Dr. Otmar Deubzer, Fraunhofer IZM, via e-mail on 11 August 2008

[9] EICTA stakeholder document "EICTA Position on RoHS Exemption 7b 20th August 2008.pdf"

[10] Commission FAQ-Document Frequently Asked Questions on Directive 2002/95/EC on the Restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) and Directive 2002/96/EC on Waste Electrical and Electronic Equipment

[11] Per Döfnäs, Ericsson; information sent to Dr. Otmar Deubzer, Fraunhofer IZM, via e-mail on 8 August 2008

[12] HP Hewlett Packard; Stakeholder document "HP Letter to the Oeko Institut – Rev3.1.pdf"

4.12 Exemption No. 7c

"Lead in electronic ceramic parts (e.g. piezoelectronic devices)"

4.12.1 Abbreviations and definitions

Curie temperature	Temperature at which piezoelectric ceramics loose their piezoelectric properties
Saturation polarization	Highest practically achievable magnetic polarization of a material when exposed to a sufficiently strong magnetic field
PTC	Positive Temperature Coefficient, materials increasing their electrical resistance with increasing temperature; as PTC ceramics used in PTC resistors or PTC thermistors
PZT ceramics	Ceramics consisting of a mixture of **P**b**Z**rO_3 and Pb**T**iO_3

4.12.2 Description of exemption

Lead and its compounds in components relevant to this exemption are used in thickfilm technology, in piezoelectric and dielectric ceramics and in PTC resistors. These applications are explained in further detail below.

<u>Piezoelectric ceramics</u>

Piezoelectric ceramics generate an electrical charge when mechanically loaded with pressure, tension, acceleration. This effect is the direct piezo effect. The polarity of the charge depends on the orientation of the crystals in the piezoceramic relative to the direction of the pressure. Conversely, the crystals in piezoceramics undergo a controlled deformation when exposed to an electrical field – a behaviour referred to as the inverse piezo effect.

Piezoelectric ceramics contain lead as high covalent compound in the ceramic matrix to achieve good ferroelectric properties in a wide temperature range. The best known performances can be reached with PZT ceramics, which are a mixture of $PbTiO_3$ and $PbZrO_3$. The lead content is between 50% and 70% by weight, depending on the proportion of zirconium (Zr) and titanium (Ti). [2]

EICTA [1] gives the following examples for products using PZT:

- Power transformers for PCs;
- Focus/zoom of mobile phone cameras;
- inkjet printers;
- hard disks;
- video recorders;
- video games;
- audio equipment;
- air conditioners;
- refrigerators and washing machines;
- smoke detectors;
- health measurement equipment.

PTC ceramics [1]

Materials increasing their electrical resistance with increasing temperature; as PTC ceramics (Positive Temperature Coefficient) used in PTC resistors or PTC thermistors. PTC ceramics is the description of an electrical material functionality which is used for overload protection in high voltage electric circuits. Usually PTC resistors are based on polycrystalline barium titanate which becomes semi-conductive by doping with further metallic oxides. The lead content within these materials is about 4% -14% by weight. PTC ceramics increase their electrical resistance with increasing temperature. Lead is also indispensable for these ceramics to achieve the required resistance-voltage characteristics and distribution of the resistance value.

PTC ceramics are mainly applied for overheat/overload protection in several products, for example in [1]:

- overheat protection in personal computers, in LCD and plasma display panel TVs, and in power supplies;
- current control in energy saving light systems and in compact fluorescent lamps;
- overcurrent protection in telephones and in measuring equipment.

Dielectric ceramics [1]

Dielectric ceramic is the basis for ceramic capacitors. Ceramic capacitors with high capacitance values for high voltage / high power applications need a lead based ceramic to achieve the necessary efficiency and to prevent self-heating. The lead content of these ceramics is about 50% by weight.

Dielectric ceramics are generally applied to prevent overheating of electrical and electronic devices or parts thereof [1]:

- Electrical and electronic control circuits;
- Ceramic capacitors for high power (exceeding DC 250 V and AC 125 V);
- HID (high intensity discharge) lamps.

Thickfilm technology

Thickfilm applications so far have been considered to be covered by exemption 5 (Lead in glass of electronic components) as well as exemption 7c (lead in electronic ceramic parts).

In thickfilm technology, thickfilm pastes are printed on a substrate, e.g. ceramics. The thickfilm paste is then sintered into the ceramic at high temperatures. This creates structures with the functionality of conductive paths, resistors, capacitors and resonators, which normally are verified using electronic components. The pastes contain lead to ensure the adhesion of the thickfilm layer on the substrate and/or to achieve conductive or other properties of the layer.

Figure 13 Thickfilm components [2]

Components based on thick film applications are very small, their lead content hence very low. [2]

Amount of lead used under exemption 7c

JBCE submitted information on the amounts of lead used under exemption 7c. Ceramics including lead is used in a large number of applications in a large number of final products making it impossible to actually survey the amounts of lead transported into the EU. [3]

JBCE estimates the amounts of lead based on electronic components for which production figures are relatively easy to grasp and adds that more ceramic components including lead may be of relevance which are not mentioned here. The figures should hence be understood as an estimate restricted to the information available to JEITA. They are not the ultimate figures on use of lead under exemption 7c. [3]

Table 7 Rough estimate of amount of lead per year used in ceramics [3]

Category	Component Name	Examples of Final Product	World Production Amount kpcs/Year *1	Amount of Lead Inclusion mg/pcs *2	Amount of Lead Used kg *3	Amount Transported into the EU kg *4
Piezoelectric Ceramics	Piezoelectric Transformer	Liquid Crystal for PCs, TV sets, etc.	78,000	900	70,200	
	Ceramic Filter	FM Radio, etc.	800,000	26	20,800	
	Ceramic Resonator (SMD	Digital Household Appliances, PCs, etc.	1,300,000	11	14,300	
	Ceramic Resonator (with lead wire)	Household Appliances, Remote Control, Mouse, etc.	1,800,000	5	9,000	
	Piezoelectric Buzzer	Air Conditioner, Washing Machine, etc.	500,000	53	26,500	
	Piezolectric Actuator (For OA Equipment)	OA Equipment	50,000	294	14,700	
Semiconductor Ceramics	PTC Thermistor	Compressor for refrigerators	150,000	390	58,500	
	PTC Heater	Drier, Household appliances, etc	360,000	1,600	576,000	
	PTC Thermistor	Power supplies, Communication equipment, Lighting, Household Appliances,	420,000	50	21,000	
Dielectric Ceramics	High-voltage capacitor	Power supplies of refrigerators, copiers, TV sets, etc.	1,300,000	78	101,400	
				Total	912,400	271,895

*1 Japan Electronics and Information Technology Industries Association Estimat
*2 There are components with different shapes and masses, but we estimate the amount of lead for an average component item
*3 Estimate values calculated as explained in *1 and *2
*4 Calculated from the GDP of the EU (2006) (14.4 trillion dollars, 29.8% of World GDP)

JBCE indicates the total amount of lead used in ceramics und exemption 7c with around 900 t per year [3]. The figures do not include the use of lead in thickfilm applications.

The amount of lead in ceramics in the European Union is estimated with around 270 t per year, excluding thickfilm applications.

As the estimates do not include all uses of lead under exemption 7c, the real amounts of lead are higher. More detailed figures are not available.

4.12.3 Justification by stakeholders

PZT ceramics

JBCE [3] claims the substitution or elimination of lead in PZT ceramics to be technically and scientifically impracticable.

For piezoelectric applications, the relationship between the Curie temperature and the constants of piezoelectric material is of crucial importance. In other words, it is essential that the piezoelectric ceramic performs according to minimum requirements at a given temperature. [3]

JBCE [3] explains crucial constants of piezoceramics.

Table 8 Essential characteristics of PZT ceramics [3]

Piezoelectric Strain Coefficient (d constant) (Piezoelectric material constant)	Indicates how efficient an electric field can generate strain of the piezoelectric material, or vice version how efficient a strain applied on the ceramic can generate an electrical field. Higher values indicate higher efficiency. d=strain / applied electrical field If the value is high, the piezoceramic can generate displacement efficiently from a low electric field. Also, the output is larger for sensors and it can be used as good sensor material with high sensitivity
Electro Mechanical Coupling Coefficient (k)	Coefficient to show the efficiency to transform and communicate electric alteration into the energy of mechanical alteration (or vice versa) due to the piezoelectric effect $k = \sqrt{\frac{\text{mechanical energy stored}}{\text{electrical energy applied}}}$ or $k = \sqrt{\frac{\text{electrical energy stored}}{\text{mechanical energy applied}}}$ [4] In order to gain filter characteristics, materials with high values in this category are essential.
Mechanical Quality Factor Coefficient	shows the extent of mechanical loss near frequencies where the piezoelectric substance resonates; in resonators and oscillators, as the value becomes higher, the oscillator becomes more efficient and the fluctuation in the resonance frequency decreases.

JBCE [3] admits that piezoelectric effects are also observed in lead-free ceramics like in barium titanate or bismuth/sodium titanate and others. However, lead-free ceramics can either not be produced in an industrial mass scale yet, or these materials fail to provide the necessary piezoelectric properties necessary for actuators, sensors, oscillators, filters, transformers etc. for comparison also see the final report on the review of Annex II of the ELV Directive [2].

The incorporation of lead into the crystal structure of ceramics is indispensable to obtain the required piezoelectric effects like high performance, the necessary Curie temperature etc.

Without the necessary minimum performance requirements in the respective applications, the piezoelectric ceramics cannot perform according to the standards and thus cannot be applied. Lowering the standards does not make sense, according to JBCE [3], as the proper function cannot be ensured. [3]

The material properties of lead-free piezoelectric ceramics, according to the stakeholders, extremely depend on the temperature and various mechanical parameters. A stable performance within typical ranges of temperature and mechanical impacts is necessary. [2]

The stakeholders also state that piezoelectric systems must be based on stable materials with marginal drift of properties and deterioration effects. The long-term performance of the mentioned material under continuous operation conditions is not known. [2]

The stakeholders conclude that the discussed lead-free piezoceramics do not show material properties to be suitable for a substitution of PZT ceramics. Additionally, these lead-free alternative piezoceramic materials cannot be manufactured in industrial scale with reproducible properties. The stakeholders do not see viable substitutes for piezoelectric ceramics at the present time. [1] [2] [3]

Exemption 11 in the Annex of the ELV Directive as well refers to the use of lead in ceramics. The exemptions from the technical point of view hence are identical. The information the stakeholders submitted is congruent with the information available on this topic from the review of Annex II of the ELV Directive.

During this review process, no opposing stakeholder views were submitted.

Dielectric ceramics

JBCE [3] states that most electronic components applying dielectric ceramics do not contain lead any more. Dielectric ceramics are used in different components, mainly in ceramic capacitors. JBCE [8] indicates that dielectric ceramics used in components with less than 125 V AC (alternating current) and 250 V DC (direct current) can be lead-free. Still, there are components currently used with electric voltage of less than the above stated parameters (for example 200 V DC) using lead, however substitution for lead-free alternatives is technically possible. [8]

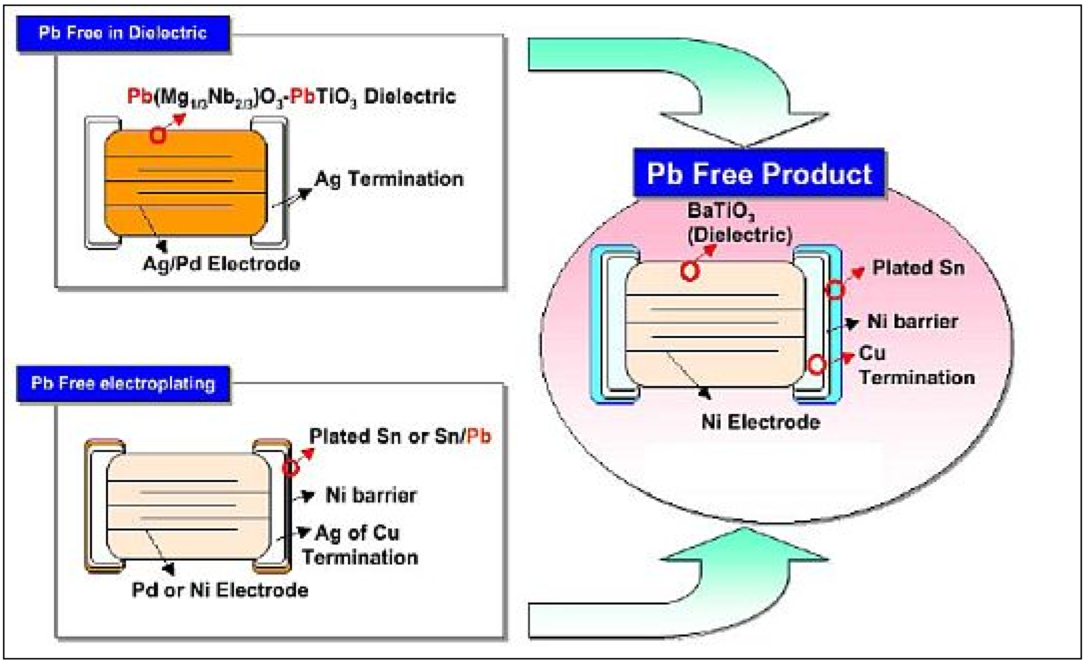

Figure 14 Substitution of lead in low voltage multilayer ceramic chip capacitors [8]

JBCE [8] states that for components still using lead-containing dielectric ceramics, but for which substitution perspective exists, a 5 to 10 year transition period would be required. Due to the wide usage and the large number of units used per device, it may generate confusion in the market unless an appropriate transition period is provided. JBCE [8] further points out that the exemption for the use of lead in ceramics was extended for the ELV Directive. If the applications for the use of lead in ceramics are restricted in the RoHS Directive, it will create confusion in the production and supply of products in the actual market. JBCE [8] would like to have a unification of the exemptions in the ELV Directive and the RoHS Directive. [8]

The substitution of lead is technically and scientifically impracticable in particular in high-voltage capacitors. No substitutes are available for high-voltage capacitors used with voltages exceeding 125 V AC or 250V DC. The use of Barium titanate has been proposed as a potential substitute material. However, it is likely to distort when voltage is imposed and the lack of strength is a concern in the application of electronic components which are used under high voltage. [1] [3] [8]

In order to obtain the function to withstand high voltage and to accumulate a large amount of electricity, a material which loses a small amount of accumulated electricity is required. Strontium titanate is appropriate for this. However, strontium titanate has a poor ability to accumulate electricity at room temperature. Thus, the ability to accumulate electricity is achieved only by adding lead as a shifter.

For high voltage capacitors using voltage exceeding 125 V AC or 250V DC, there is no prospect at present for lead substitution. Same degree of functionality cannot be assured for capacitors composed of dielectric materials other than ceramics either. The function of high voltage capacitors is regulated in safety standards, with which lead-free materials cannot comply.

PTC ceramics

JBCE [3] states that the solid-solution ceramics of Barium titanate and lead titanate is the only mass-produced material which can raise the Curie temperature of Barium titanate to the required level. Other than lead, there is no such material, which at the same time can be mass-producted and yields the necessary reliability.

If the Curie temperature can be 120 centigrade or below, it can be produced by adding strontium to Barium titanate. However, the product life and withstand voltage is poorer than using lead and there are problems to be solved before practical application. For a substitute material in case the Curie temperature of more than 130 centigrade is required as in overcurrent protectors, research and development of solid solution material of natrium and bismuth and Barium titanate is advocated. However, as the reliability and the mass-production technology is not ensured and there is no prospect of mass-produced supply of workable substitute material, the completion of substitution within several years is not in sight.

Exemption 11 in the Annex of the ELV Directive as well refers to the use of lead in ceramics. The exemptions from the technical point of view hence are identical. The information the stakeholders submitted is congruent with the information available on this topic from the review of Annex II of the ELV Directive.

No opposing stakeholder views were submitted during this review process.

Thickfilm technology

Lead is used in thickfilm technology. According to JEITA [2], alternatives with the properties equivalent to lead-containing glasses/thick film layers are not available on the market [2]. Lead-free alternatives to lead-containing thickfilm layers comprise borosilicate zinc glass and borosilicate bismuth glass; resistor alternatives include bismuth ruthenate, sodium ruthenate, strontium ruthenate and others. They can, however, not compete with the lead-containing thickfilm materials.

Technical properties, such as e.g. the high heat resistance in high operating temperature applications, make thickfilm applications indispensable. Conventional printed wiring board technologies hence cannot replace the thickfilm technology.

Roadmap towards phase-out of lead in ceramics

JBCE submitted the JEITA roadmap towards the substitution of lead in ceramics, as Figure 15 shows.

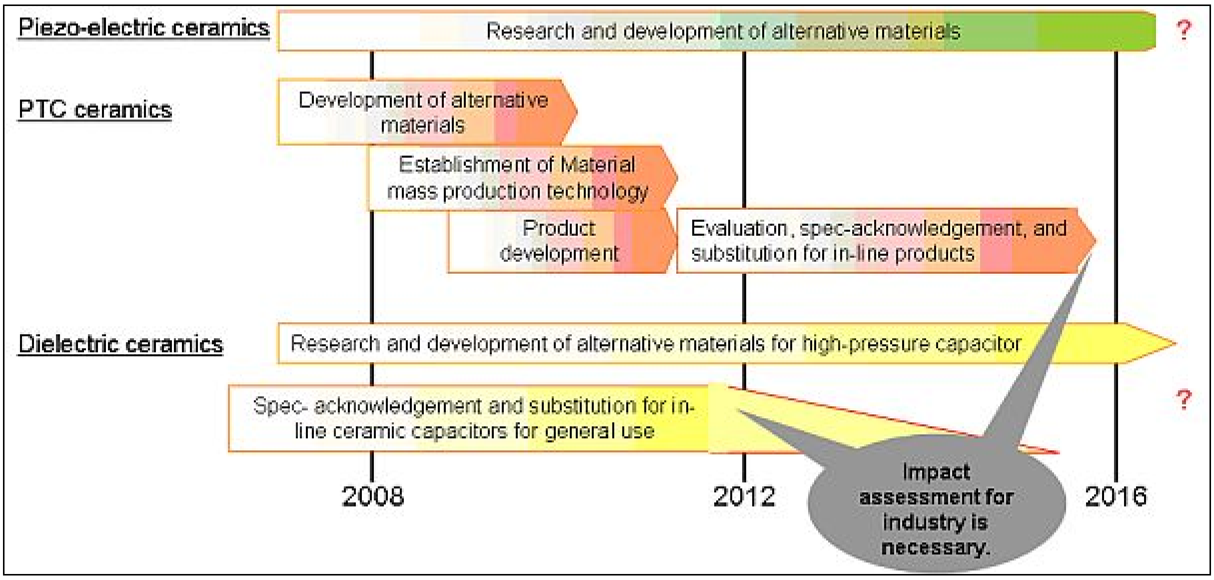

Figure 15 Roadmap to the substitution of lead in ceramics [3]

The above roadmap shows for the PTC ceramics that there are several steps to go from the pure availability of a substitute material to its applicability. This is plausible, as materials need to be tested and qualified for applications.

Lead-free substitutes for the ceramic materials discussed are not expected to be applicable before around 2015.

Opposing stakeholder views are not available.

4.12.4 Alignment of the RoHS and the ELV Directive

Developments in the review of exemption requests in the RoHS Directive

Lead in thickfilm applications has been considered to be present either as (part of) a glass or ceramic. Exemption no. 5 “Lead in glass of […] electronic components […]” and/or no. 7 “Lead in electronic ceramic parts (e.g. piezoelectronic devices)” were therefore believed to cover the use of lead in thickfilm applications.

In a previous stakeholder consultation round, a manufacturer of cermet-based trimmer potentiometers had requested a RoHS-exemption for the use of lead in thickfilms [5]. The manufacturer stated that he does not see his application either under the existing RoHS exemption no. 5 “Lead in glass of cathode ray tubes, electronic components and fluorescent tubes” or under no. 7 “Lead in electronic ceramic parts (e.g. piezoelectronic devices)”.

The thickfilm is used to generate the resistive layer on the ceramic base of the trimmer potentiometer. The manufacturer said that this resistive layer is a homogeneous material, as it can be mechanically separated from the ceramic base. This homogeneous material, the thickfilm layer containing the lead, for itself is neither a glass nor a ceramic material. Exemption 5 or 7 c therefore, according to the applicant, do not cover the use of lead in this thickfilm layer.

It is in the responsibility of the manufacturers to define the homogeneous material as well as to decide whether a specific exemption covers the specific use of a material, which is otherwise banned in the RoHS Directive. Neither the reviewers nor the Commission take such a decision. As the applicant's arguments were plausible, the consultants recommended the Commission to grant the exemption [6].

Review of Annex II of the ELV Directive

During the review of Annex II of the ELV Directive, given the above developments in the RoHS exemption review, it was discussed with the stakeholders whether exemption no. 11 of Annex II ELV Directive ("*Electrical components containing lead in a glass or ceramic matrix compound except glass in bulbs and glaze of spark plugs"*) actually covers the thickfilm applications of lead-containing thickfilm layers in vehicles.

At the stakeholder meeting in Brussels on 10 October 2007, after consultation with the Commission, the contractor had proposed to amend the existing wording of exemption 11 in Annex II of the ELV Directive in order to increase the legal security for industry and to maintain the consistency between the RoHS and the ELV Directive:

Electrical components containing lead ***in a thickfilm layer (…)*** *or in a glass or ceramic matrix compound except glass in bulbs and glaze of spark plugs.*

The stakeholders decided that the wording of the exemption in the ELV Directive "*Electrical components containing lead in a glass or ceramic matrix compound […]"* covers the use of lead in thickfilm applications. They stated that, assuming the thickfilm layers are homogeneous materials, the thickfilm layer contains the lead as a glass or ceramic matrix compound. The homogeneous material itself hence does not need to be a glass or a ceramic, in opposite to exemption 5 and 7c in the RoHS Directive. The stakeholders therefore claimed the wording of exemption 11 ELV Directive to cover thickfilm applications and asked not to change the wording [2]. The consultants followed the stakeholders request in their recommendation to the Commission.

Review of the Annex of the RoHS Directive

In this review process of the Annex of the RoHS Directive, it was discussed whether to adopt the wording of exemption 11 ELV Directive. As technically both exemptions cover the same issues, an alignment would be justified.

During the stakeholder workshop in Brussels on 10–12 June 2008, the stakeholders in principle supported the arguments raised during the review of Annex II of the ELV Directive. Nevertheless the wording was decided to be modified to further clarify the scope of this exemption:

"Electrical ***and electronic*** *components which contain lead in* ***a glass or ceramic*** *or a glass or ceramic matrix compound (e.g. piezoelectronic devices)".*

This wording covers the following issues:

- Addition of "electronic components"
  Some legislation explicitly refers to "electrical and electronic" applications or equipment, like for example the WEEE Directive and the RoHS Directive. Exemption 5 and 7c in its current wording also refer to "electronic" components. This might raise concerns that 7 c might only apply to electrical, but not to electronic components. The stakeholders agreed to add the electronic components modification in order to avoid insecurities. [7]
- Lead in "a glass or ceramic"
  As discussed, the wording "lead in a glass or ceramic matrix compound" according to the stakeholders allows the use of lead in a homogeneous material, which itself is neither a glass nor a ceramic. The only precondition is that the lead is included in a glass or ceramic matrix compound, which, according to the stakeholders, is the case e. g. in thickfilm applications.
  The remaining question was whether this wording would also allow the use of lead in a homogeneous material, if this material itself actually is defined as a glass or a ceramic.

  To avoid insecurities, the wording was completed with the addition of "lead in glass or ceramic".

The stakeholders agreed to this wording. They further on recommended the European Commission to provide a definition of a 'matrix compound' in a guidance document or FAQ. [7]

Consequences for the current exemption 5

If the Commission follows the proposal for the new wording of exemption 7 c, the "lead in glass […] of electronic components" part can be removed from exemption 5. This part of the exemption would then be integrated into exemption 7 c.

4.12.5 Critical review

Situation after review of information available until 31 October 2008

Under exemption 7c, lead is used in PZT ceramics, in PTC ceramics and in dielectric ceramics. The stakeholders explain that at the current state of technology, lead cannot be replaced in PZT ceramics and in PTC ceramics. The JEITA roadmap (Figure 15 on page 106) shows that for these uses of lead a substitution is not to be expected prior to 2016, hence not before the next general review of the exemptions.

For dielectric ceramics, the substitution of lead is technically practicable in components for a maximum voltage of 125 V AC or 250 V DC. For higher voltage applications, the substitution of lead is not yet possible, as the stakeholders explain. There is no substantiated stakeholder information available contradicting this information, neither on the feasibility of low voltage lead-free dielectric ceramics nor on the impossibility to replace lead in the higher voltage dielectric components.

Art. 5 (1) (b) requires the restriction of lead in dielectric ceramics to those areas where the substitution is technically impracticable. Exemption 7c therefore has to be repealed for lead in dielectric ceramics of electrical and electronic components for a maximum voltage of 125 V AC or 250 V DC. JBCE [8] asked for a transition period of at least five years. The dielectric components are widely used and in large numbers, and the components of some manufacturers still contain lead although the substitution is technically feasible. On request, the stakeholders could, however, not explain plausibly why and for which components or applications the long transition period of five years or more would be necessary.

Situation after 31 October 2008

The above review is based on the information available on 31 October 2008.

In December and afterwards, the reviewers received information that

1. the definition of "dielectric ceramics" might not be sharp enough in order to allow an unambiguous and clear understanding of the exemption wording [9].
2. the voltage limits of 125 V AC and 150 V DC may be too high for certain types of components containing dielectric ceramics in specific applications. The above proposed exemption wording would thus ban the use of lead in specific components, where viable alternatives are not yet available, or not yet long enough in order to allow a proper qualification of these components in all applications [10]. Other manufacturers of such components seem to experience similar problems.

Nevertheless, according to the information status after October 31, there seem to be remaining specific components in particular applications in the low-voltage area where lead-containing dielectric ceramics can not yet be replaced, or not within a few months. According to ZVEI [10], although most of these components using dielectric ceramics are available in lead-free ceramics, there is a remaining portion, where a replacement was not possible in particular applications. In consequence, manufacturers of ceramic capacitors still have to produce a limited number of low voltage capacitors using lead containing dielectric ceramic.

ZVEI [10] states that a manufacturer of components cannot identify all applications of the components, especially when considering the sales channels via resellers (distributors). Thus, a component manufacturer can only see, that still there is a small scale business with such "old" technology components, but cannot finally know, but does not know all the users and their specific applications.

Technically, drop in replacement with lead-free ceramic components using dielectric ceramics are not possible in all applications. The electrical properties of the ceramics are slightly different. In consequence, a user of the capacitors is forced to analyse all applications of those in all equipment, whether a re-design of the electronic circuit is necessary or not. [10]

This takes time, as such low voltage capacitors are widely used, and a typical customer may have to check hundreds of systems, test with new alternative components, and obtain the approvals from his customers, or authorities in case of applications in regulated areas. [10]

The remaining question vice versa is whether users of such components had not applied for exemptions, or reacted earlier. ZVEI [10] explains that a common and full material declaration system is not introduced to the whole electronic industry - thus most of component users, especially SME, do not have information on hand, whether ceramic capacitors contain lead or not. They only know, that the products they purchase are "RoHS-compliant", but not, whether this compliance is based on an exemption or not. The only chance for a component manufacturer to make the whole market aware of such a change to lead-free ceramics is, to publically announce the discontinuation of the delivery of such specific products, and to wait for the response from concerned customers, inform about alternative types and provide technical information and support for the conversion process. [10]

Obviously, manufacturers had informed their customers about the recommended changes of exemption 7c and the resulting consequences, and then only received feedback from customers and distributors.

This may at least in parts explain the difficult information flow.

As the information was available as late as in December 2008, it could not be clarified which components and which applications exactly would be affected in case of a ban of lead in dielectric ceramics. This cannot be decided on the spot, as the technical complexity requires an in-depth investigation and discussion with the different stakeholder sides. Given the above situation in industry, it must be doubted that this question could actually be clarified to a point that would allow drawing an exact line that would adequately address those specific cases where lead cannot yet be substituted in dielectric ceramics.

It is clear from the available information, that at least for most of the application spectrum, appropriate lead-free dielectric ceramics have been available for some time for low voltage uses. A long and general transition period of five and more years would hence not be justifiable by Art. 5 (1) (b). There are no hints that the cancellation of exemption 7c for these dielectric ceramic applications might have severe impacts on the availability of such components, or on the overall electrical and electronics industry sector.

A long transition period would not be justifiable with respect to single manufacturers that have shifted to components based on dielectric ceramics too late, where technically feasible. It is clearly stated in the RoHS Directive that all exemptions are reviewed at least every four years and therefore are temporary. Manufacturers hence can be expected to shift towards the use of lead-free ceramics once this is technically practical. The broad availability of lead-free components shows that his has been the case for some time already. Recommending a transition period to accommodate the needs of those manufacturers that have delayed the transition cannot be a reason for the continuation or a long transition period in line with Art. 5 (1) (b).

As it is not possible with respect to the end of the review process to further on investigate and discuss the issue sufficiently with the component manufacturers and those sectors applying such components, it is recommended to set the expiry of 31 December 2012 for lead in dielectric ceramics. Under the given circumstances, this expiry date would accommodate the requirements of Art. 5 (1) (b) as well as the complex technical and supply chain situation:

- An expiry date 31 December 2012 is close enough to appraise the fact that lead-free alternatives are available for most applications, and it is a clear signal to component manufacturers and users to shift to lead-free wherever possible as early as possible.
- The expiry date 31 December 2012 gives component manufacturers and component users time to shift and qualify more lead-free ceramic components in those particular cases where such alternatives so far have not been available or not yet long enough to qualify them for specific applications.
- The expiry date 31 December 2012 keeps the door open for industry to apply for specific exemptions in such specific cases where the substitution of lead in dielectric ceramics is not possible until end of 2012. Assuming the amendment of the RoHS Annex end of 2009, industry has a reliable time-frame to have specific exemptions installed before the expiry of the exemption.

Assuming that the Annex of the RoHS Directive will be amended until the end of 2009, it is recommended that exemption 7c expires on 31 December 2012 for lead in dielectric ceramics of electrical and electronic components for a voltage of less than 125 V AC or 250 V DC.

For all other uses of lead in ceramics under exemption 7c, viable lead-free substitutes currently are not available and are not expected to be available within the next years. Assuming that each exemption is required to have an expiry date, and in line with the COM requirements, the consultants propose 31 July 2014. This gives the stakeholders opportunities to submit evidence in the next review of the Annex for the further need of these parts of exemption 7c beyond 2014, if appropriate.

It could not be clarified why the definition of dielectric ceramics should not be sharp enough to allow a clear and unambiguous understanding of the exemption. The concern could not be substantiated to a degree that would allow a better and clearer wording and definition of “dieelectric ceramic”.

4.12.6 Recommendation

The consultants recommend setting an expiry date for lead in dielectric ceramics for low voltage components. Lead-free alternatives are broadly available and already are in use. However, there are clear hints that in specific components and applications, the substitution of lead in dielectric ceramics is not yet possible. Due to the complex technical and supply chain situation, it could not be further clarified which components in which applications would be affected.

Given the broad availability of lead-free ceramic components, the general continuation of the exemption until 2014 would not be in line with Art. 5 (1) (b). Assuming that the Annex of the RoHS Directive will be amended until the end of 2009, it is recommended that this part of the exemption expires on 31 December 2012 in order to adequately accommodate the different legal and technical requirements under the given circumstances.

For all other uses of lead in ceramics under exemption 7c, viable lead-free substitutes currently are not available, and are not expected to be available in the next years, according to the stakeholders. 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 these parts of exemption 7c beyond 2014, if appropriate.

The exemption must be split to reduce the complexity of the wording, which is proposed as:

- *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. piezo-electronic devices) until 31 July 2014, and for the repair, and to the reuse, of equipment put on the market before 1 August 2014.*
- *Electrical and electronic components for a voltage of 125 V AC or 250 V DC or higher which contain lead in a dielectric ceramic until 31 July 2014, and for the repair, and to the reuse, of equipment put on the market before 1 August 2014.*
- *Electrical and electronic components for a voltage of less than 125 V AC or 250 V DC which contain lead in a dielectric ceramic until 31 December 2012, and for the repair, and to the reuse, of equipment put on the market before 1 January 2013.*

The above wording comprises the lead in “glass of electronic components” part from exemption 5, which is therefore deleted from exemption 5. At the same time, the wording, according to the stakeholders, covers the use of lead in thickfilm applications, which had been contentious with the previous wording of exemption 7c (and exemption 5).

4.12.7 References

[1] EICTA online stakeholder consultation document “Exemption_7c_EICTA_and-others_1_April_2008.pdf”

[2] Öko-Institut e.V./Fraunhofer IZM: Adaptation to Scientific and Technical Progress of Annex II Directive 2000/53/EC, final report January 2008, document “Final report ELV Annex II revision_rev.pdf”, download from http://circa.europa.eu/Public/irc/env/elv/library?l=/stakeholder_consultation/evaluation_procedure/reports/final_report/report_revision/_EN_1.0_&a=d; last access 20 October 2008

[3] JBCE online consultation stakeholder document “Exemption-7c_JBCE_1_April_2008.pdf”

[4] http://www.piezo.com/tech1terms.html#coupling, last access 20 October 2008

[5] Online stakeholder consultation for RoHS exemption requests, http://circa.europa.eu/Public/irc/env/rohs_6/library?l=/exemption_requests/trimmer_potentiometer/proposal_2pdf/_IT_1.0_&a=d, last access 20 October 2008

[6] Öko-Institut e.V., Fraunhofer IZM: Adaptation to Scientific and Technical Progress under Directive 2002/95/EC; final report; document “Final_Report_RoHS-Exemptions-October_2007.pdf”

[7] Information from Pascale Moreau, EPSON Europe, on behalf of EICTA; sent via e-mail to Dr. Otmar Deubzer, Fraunhofer IZM, on 24 July 2008

[8] JBCE stakeholder document "ROHS Exempted Application - Ceramic.doc"

[9] Stakeholder information via e-mail on 16 December 2008 and 9 January 2009 received from Lars Brückner, JBCE

[10] ZVEI stakeholder document "Concerns RoHS exemption 7c_01-2009_2.pdf" from January 2009

4.13 Exemption No. 8

"Cadmium and its compounds in electrical contacts and cadmium plating"

The complete wording of this exemption currently is:

Cadmium and its compounds in electrical contacts and cadmium plating except for applications banned under Directive 91/338/EEC amending Directive 76/769/EEC relating to restrictions on the marketing and use of certain dangerous substances and preparations.

NEC/Schott [1] in the fourth stakeholder consultation in 2005 had submitted an exemption request to no longer allow the use of cadmium in "[…] applications of one-shot operation function such as thermal links […]". NEC/Schott claimed to have cadmium-free solutions, and Öko-Institut recommended to remove the mechanical one-shot pellet type thermal cut-offs from the exemption in July 2007. The COM did not follow this recommendation, and exemption 8 is currently still in place without an expiry date.

In the current review process of the RoHS exemptions, several stakeholders ask for maintaining the exemption [2]-[10]. EACCM (European Association of Contact Material Manufacturers, [11]), KEMI Swedish Chemicals Agency [12], and a Chinese company [13] submitted stakeholder documents asking to restrict or to repeal exemption 8.

4.13.1 Description of exemption

Electrical contacts contain 10–12% of silver-cadmium-oxide (AgCdO). It prevents arcs when opening the contacts in case of high power / high current. Further on, it prevents the corrosion of electrical contacts which would reduce the durability and reliability. Corrosion can result in welding of the contacts, which would then destroy the functionality of the contact.

Cadmium-containing electrical contacts are used in manifold applications:

- switches, which again are used in many applications ranging from circuit breakers in information and telecommunication equipment, washing machines etc.;
- doorlocks in washing machines;
- thermal links for safety applications etc.