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EUROPEAN UNION RoHS EXEMPTION REVIEW CASE STUDY

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ABSTRACT

The European Union's Directive for the Restriction of the use of certain Hazardous Substances (RoHS) has been applicable to new electrical and electronic equipment put on the EU market from 1 July 2006 [1]. When the Directive entered into force in February 2003, provisions were made in the Annex to exempt certain uses of otherwise restricted substances in specific cases where the negative effects were likely to outweigh the environmental, health and/or consumer safety benefits of the substitution. As required by the Directive, a review must be conducted every four years to determine whether there is valid scientific data to support the continuation of each exemption. With the previous review of exemptions conducted in 2004 that included the initial ten exemptions and the first group of modifications / additions, 2008 brought the first full review of the portfolio of exemptions after the Directive came into force.

During the exemption review, representatives of individual companies and those affiliated with industry associations presented the technical progress applicable to approximately 30 exemptions and submitted position statements for review by a consultant selected by the European Commission. This paper will share a case study of activities undertaken to develop and submit a position on the exemption allowing the use of lead in solders for servers, storage and storage array systems, network infrastructure and similar equipment, exemption 7b. It will also provide some brief highlights of the exemption reviews of the 'lead used in compliant pin connector systems' and the 'lead in solders for flip chip packages' exemptions, also critical to high reliability server systems.

In addition, the paper will present an exemption transition strategy that could be applied to the phase out of any exemption. With technical advances in many areas of materials development and the goal of the European Commission to reduce the scope and number of exemptions, it can be expected that the electronics industry will face several years of change management as RoHS materials allowed today by an exemption are replaced. Developing a transition roadmap throughout the supply chain and maintaining an accurate materials content database to document compliance are an essential but complex task given the scope of expected modifications. This complexity is multiplied by the many other worldwide regulatory initiatives affecting hardware and environmental compliance material tracking needs.

Learning from this exemption review should be applied now to assure adequate industry preparations for the next review, even while the industry transitions away from several exemptions slated for near-in expiration.

Key words: RoHS, exemptions, environmental regulations

BACKGROUND

The initial exemptions in the RoHS Directive included specific uses and/or applications of several of the restricted substances: mercury, lead, cadmium and hexavalent chromium. Of critical interest to the electronic packaging experts specializing in materials and process development for servers and other high reliability electronic systems were several allowances for the use of lead (Pb). These exemptions include:

- Lead in high melting temperature type solders (i.e. tin-lead solder alloys containing more than 85% lead),
- Lead in solders for servers, storage and storage array systems (exemption granted until 2010),
- Lead in solders for network infrastructure equipment for switching, signaling, transmission as well as network management for telecommunication

High melting temperature solders containing >85% lead are often used for high reliability flip chip bumps, some soldering processes for ceramic packages, and die attach for high power, wirebonded devices. It was recognized in 2004 that these high melting alloys did not have comparable replacements in terms of mechanical properties that had been proven in the lead-free alloy families.

Lead bearing solders have been the primary alloys for the assembly processes used within electronic equipment for decades. The quest to replace these solders with lead-free alloys is a tremendous task that has been undertaken by the electronics industry. It was recognized that to require this transition to lead-free solders prematurely in high performance, high reliability electronic equipment such as servers, storage, storage arrays, network infrastructure and telecommunications equipment that perform critical tasks could pose a health and safety risk to the public. To allow time for adequate development and reliability evaluations of the new lead-free solders, the exemptions for 'lead in solders' were included in the Directive annex.

These exemptions addressed some of the most critical risk areas for high performance systems. The industry, however, began to identify several additional uses of lead that were not covered by the original exemptions in the annex and posed considerable risk level for replacement with lead-free alternatives.

2004 EXEMPTION REVIEW

In 2004, a Stakeholder Consultation was announced by the European Commission with the purpose of reviewing several exemptions in the annex to determine if these exemptions should be maintained or deleted and to consider the proposal for several additional exemptions to be added to the annex.

Included in the list of exemptions to be reviewed was the 'lead in solders' exemptions for both servers and network infrastructure equipment. Among the new exemptions proposed for consideration were:

- Lead used in compliant-pin VHDM (Very High Density Medium) connector system
- Lead in solders to complete a viable electrical connection internal to certain Integrated Circuit Packages (Flip Chips)

Server Exemption Considerations

The need for the continued availability of the 'lead in solders for server' exemption was highlighted based on the high reliability requirements for systems in this category performing mission critical applications for businesses and government. These systems are expected to be in operation 24 hours a day, seven days a week for at least ten years with very little outage time during these years of operation [2]. Until lead-free solders could be proven as reliable for such high performance, high reliability applications, the need for the continued use of traditional lead-tin solder was argued [3]. In addition, compatibility issues with lead-free solders were identified for the more complex printed circuit boards (PCBs) typically used in server systems and the risk for component damage when performing assembly at the higher lead-free reflow temperatures was documented [4].

Compliant Pin Exemption

Compliant pin connectors are inserted into the PCB and provide a mechanical / electrical connection without the need for solder. Through innovative pin shank designs that compress for insertion, high thermal mass, high density connectors can be attached and provide a reliable interconnection. To help minimize the high force required for insertion, tight tolerances are required on both the pin and the plated-thru-hole (PTH) in the PCB. Even with appropriate design and manufacturing dimensions, this forceful insertion can cause damage to the PTHs in the PCB. Lead (Pb) plating on the pins has traditionally been critical in providing lubrication to prevent damage to the PTH during insertion and in the case of rework, removal. With lead-free finishes recording higher insertion forces [2], the increased risk for PTH damage was significant enough to make a case for an exemption.

Flip Chip Exemption

One application referenced to justify the exemption for lead in high-melting temperature solders was for their use in flip chip interconnects. In ceramic packages, the flip chip bump is typically >85% lead (Pb) and joined to the metallized pad on the substrate using only flux. The finished joint as shown in Figure 1, would thus meet the criteria for high-melting temperature solders set forth in the exemption in the Directive annex.

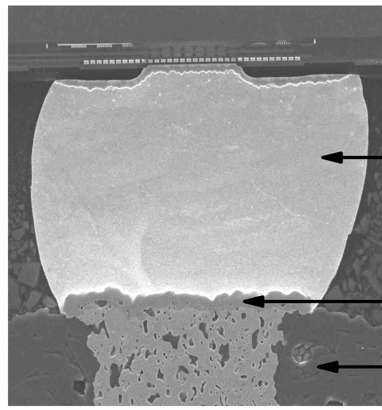

Figure 1. Vertical Cross Section of a flip chip solder bump (97Pb-3Sn) reflow attached to a metallized pad on the Ceramic Chip Carrier [5].

When joining high-melting temperature solder flip chip bumps to organic substrates, eutectic lead-tin solder is used to form the solder joint. This resulting solder interconnection as shown in Figure 2, can fall below the >85% lead (Pb) criteria and would not be allowed under the initial Directive exemption.

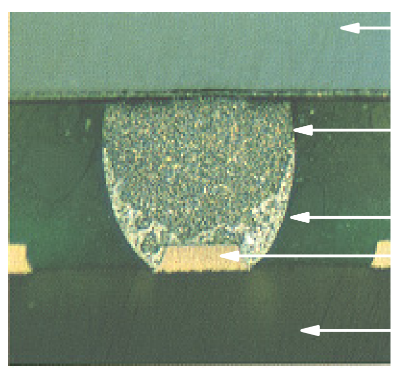

Figure 2. Vertical Cross Section of a high-melting temperature Flip Chip solder bump (97Pb-3Sn) attached to a metal pad on a Plastic Chip Carrier with low-melting point solder (63Sn-37Pb) [5].

Because lead-free flip chip interconnects were largely unproven in 2004, a more broadly applicable flip chip exemption was proposed to allow the continued use of lead-tin solders. This exemption would allow time for the industry to address the primary lead-free flip chip reliability issues of electromigration and underfill adhesion during subsequent ball grid array (BGA) and card assembly reflows during which the flip chip interconnect could also melt [3].

Review Conclusions

Documentation was submitted during the Stakeholder Consultation and industry expert reviews were conducted to gather additional technical information and understanding. Based on this information, a recommendation was submitted to the European Commission [4] to support, among other exemptions, the following:

- Lead in high melting temperature type solders (i.e. tin-lead solder alloys containing more than 85% lead),
- Lead in solders for servers, storage and storage array systems, network infrastructure equipment for switching, signaling, transmission as well as network management for telecommunication
- Lead used in compliant-pin connector systems
- Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit Flip Chip packages

In regard to the 'lead in solder for server' exemption, it was further recommended to set no expiry date, but to review the exemption at least every four years, as required by the RoHS Directive, to determine at what point lead-free solders have been shown to be sufficiently reliable to terminate the exemption. It was estimated that at least five years of experience with lead-free solders in the consumer market segment would be required to provide enough field experience to understand how to extrapolate accelerated test data. In addition, the report proposed definitions for both 'solders' and 'servers' within the context of the exemption. These recommendations were accepted by the European Commission – in consultation with the Member States - and confirmed in a decision published in October 2005 [6].

2006 RoHS IMPLEMENTATION

Industry development activities continued to increase the knowledge and understanding regarding the use of lead-free solders for card assembly as the July 1, 2006 implementation date for the RoHS Directive approached. The consumer market would prepare for the implementation of lead-free soldering through academic, consortia and individual corporate efforts.

Tin-lead Assembly for Servers

Although exempt from lead-free soldering requirements, server products were still required to comply with the RoHS Directive. Control specifications were critical in documenting RoHS requirements and distinguishing those requirements between systems that were eligible for the 'lead in solders' exemption [7], such as server and storage systems, and those that were not [8], such as printers, self-checkout systems and point of sale terminals.

Despite the proposed definition of 'solders' including all materials that become part of the final solder joint, including solder finishes on components or printed circuit boards [4], a more conservative interpretation was chosen by IBM that required PCB surface finishes and component terminal finishes to be lead-free while continuing to solder with a tin-lead alloy. This conservative position allowed for the same component part numbers and the same PCB finish processes to be used by all systems, independent of the applicability of the 'lead in solder' exemption. A PCB surface finish such as organic solderability preservative (OSP) and a component terminal finish such as matte tin, with appropriate tin whisker mitigation techniques, could be used in either a tin-lead or lead-free soldering process.

Initially, those companies continuing with tin-lead assembly under the 'lead in solders' exemption could also maintain a supply of tin-lead BGA components, thus avoiding the risks of 'mixed solder assembly' [3]. As the demand for commodity components such as memory shifted from tin-lead to lead-free BGA with the introduction of lead-free assembly in the consumer market, the server market, however, was forced to assess these lead-free BGA components for backward compatibility in a tin-lead assembly process.

Integrating components with lead-free BGAs into a tin-lead card assembly process typically requires an elevation in the reflow temperature to assure good mixing of the SnAgCu ball with the SnPb solder paste. The impact of increased temperatures to the process will be dependent on the thermal mass of the SnAgCu BGA component as well as the largest SnPb BGA component. Acceptable thermal fatigue reliability can be achieved, by verifying good mixing within the resulting solder joint during process development [9]. Given the likely requirement for higher reflow temperatures to achieve full solder joint mixing, additional care must be taken to assess the robustness of the PCB [10] and any temperature sensitive components for compatibility with the mixed solder assembly process [11].

Lead-free Assembly Development for Servers

Even while production continued with tin-lead solders, those in the server and related markets began assessing the additional requirements for migrating a lead-free assembly process used by the consumer market segment for use in more complex, higher reliability systems [12]. Two of the driving forces for this work were the anticipation of the next EU RoHS exemption review and the supply chain reality of a decreasing supply of tin-lead components. If the 'lead in solders' exemption was to continue, evidence would have to be presented during the anticipated 2008 exemption review to justify an on-going need. While successful mixed solder assembly processes have been established, the continued evolution of the supply chain to a lead-free assembly focus is expected to further reduce the availability of SnPb BGAs, thus further complicating mixed solder assembly.

This work highlighted areas for continued investigation such as improved robustness of thicker, more complex PCBs through lead-free reflow temperatures [10], copper dissolution during wave solder and PTH rework [13, 14], TSOP solder joint reliability understanding [12], and compatibility of lead-free PCB surface finishes with a variety of environmental conditions [15]. Studies to address these concerns and others continued as the industry also prepared for the 2008 exemption review.

2008 EXEMPTION REVIEW

In January 2008, a Stakeholder Consultation was announced with the purpose of reviewing the approximately 30 existing EU RoHS exemptions. The scheduling of this review was consistent with the Directive requirements that a review of exemptions be conducted at least every four years to consider for elimination any exemption where the substitution of the restricted substances was possible. Guidelines for the submission of comments were published and industry representatives from individual companies and trade associations began to compile and organize their commentary.

Compliant Pin Exemption

While independent of the ‘lead in solder for server exemption’, since it does not involve any soldering processes, this exemption which permits the continued use of lead (Pb) containing coatings on compliant pin connectors has been critical for server applications. Summary information on the development and qualification work towards the elimination of lead in the compliant pin shank coatings was gathered and submitted for review [16].

Compliant pin connector systems are typically used in more complex PCBAs and not as often in consumer electronics. Several different pin styles available in the industry are found on compliant pin connectors. Examples of these pin styles, “eye of needle,” “C-press,” “bowtie” and “action pin” are shown in Figures 3-6, respectively.

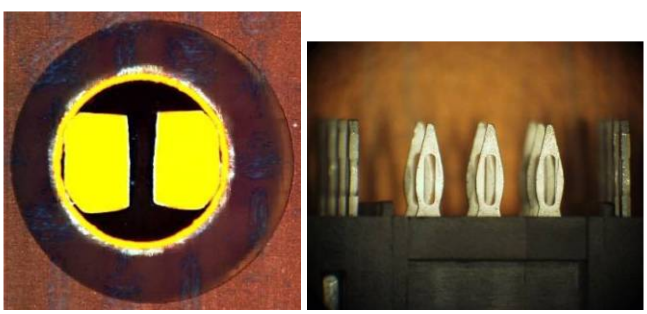

Figure 3. Eye of needle connector configuration.

Figure 4. C-press connector configuration.

Server applications require thicker printed circuit boards (PCB) and do not accept any internal defects or damage to the PCB material surrounding the plated through hole (PTH). These applications have complex printed circuit board assemblies that require the capability to rework connector sites to maintain a high yield and reduce the amount of scrap hardware that must be disposed.

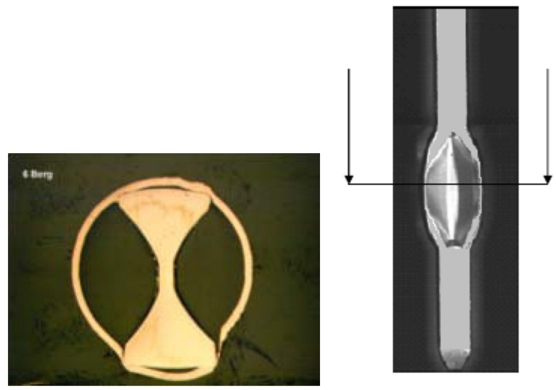

Figure 5. Bowtie connector configuration.

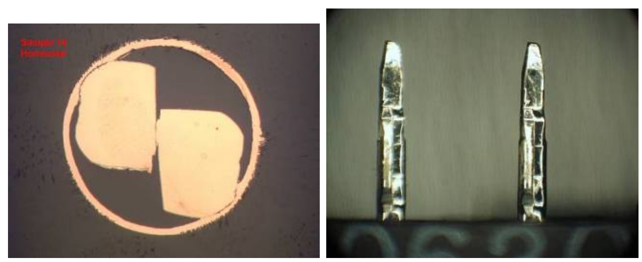

Figure 6. Action pin connector configuration.

Evaluation of some lead-free compliant pin connectors through the insertion and removal processes has found the change to lead-free coating to be acceptable. Positive results have been obtained in qualifying “eye of needle” and “C-press” configurations from several suppliers. Testing of other lead-free compliant pin connectors however, such as “bowtie” and “action pin” designs, has uncovered unacceptable damage to plated through holes (PTH) in the PCB, especially after rework, removal of a defective connector and replacement with a new connector. This damage is due to the ‘harder’ lead-free finish which requires significantly higher insertion/retention forces. Cross section examples of an acceptable insertion and an unacceptable rework are shown in Figures 7 and 8, respectively.

The results for the “eye of needle” designs, however, vary based on supplier and connector specifics. Some “eye of needle” designs have positive qualification results, while others have failed due to PTH damage. Failure mechanisms are not yet well-understood. Contributory factors to these failures may be the design of the compliant section, the interference fit between the compliant section and the PTH, and/or the material properties of the plating. The review submission argued that pending a complete understanding of the failure mechanism(s), and a practical means of eliminating them, a continuation of the exemption was necessary in some form.

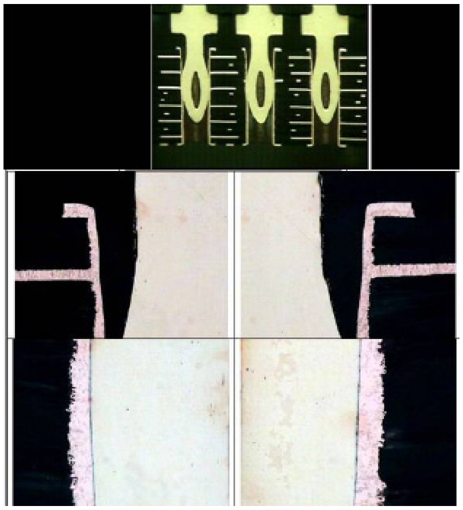

Figure 7. Cross section showing acceptable results after connector insertion.

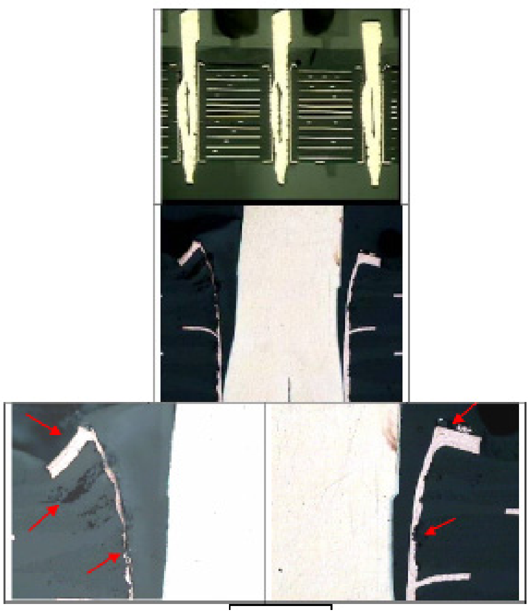

Figure 8. Cross section showing unacceptable PTH damage after rework.

Lead in Solder for Servers Exemption

Many development programs that were initiated around 2006 to extend the industry's knowledge of lead-free processing to server-class assemblies had made significant progress by the time of the 2008 exemption review. These efforts resulted in a better understanding of the technology limits of the currently available lead-free processes. Despite the 'lead in solders' exemption covering just a portion of the overall electronics market, the server, storage, network infrastructure and telecommunications equipment eligible for this exemption has quite a broad scope in terms of PCB and assembly complexity. For this reason, lead-free assembly can be successfully implemented on certain server [17] and storage [18] products, while more complex products continue to face challenges [19, 20]. Industry representatives worked together to compile a summary of the accomplishments and remaining challenges to submit as a position paper [21] for the review.

Even as entry-level server, blade and certain network infrastructure equipment (NIE) begin production with lead-free solder assembly, concerns remain for a complete conversion of more complex, high reliability systems. Two areas of particular concern have been identified. The complex printed circuit board assemblies in these systems present challenges in developing a robust assembly process accommodating both the higher temperature lead-free alloys and the temperature limitations of the PCBs, components and connectors. These systems also require a proven method to forecast long term reliability to meet the stringent requirements placed upon them.

Despite industry progress in developing acceleration factor models relating lead-free solder fatigue test results to field performance [22], more work is required for complete understanding of issues such as solder aging [23, 24], microstructural, grain orientation and alloy effects [25, 26, 27, 28, 29].

Some of the areas where temperature compatibility issues remain include PCBs [10], temperature sensitive components, [11] and connectors. Printed circuit board robustness for 245C reflow temperature compatibility has only been proven for PCBs up to 3.3mm (130mils) thick, however high end servers require thicker PCBs. As these qualifications have progressed, new failure modes have been discovered and must be thoroughly understood. The need for thicker cards, large arrays of fine pitch vias, low loss tangent materials, 2 oz copper power planes and other complexities in construction increase the challenges in qualifying PCBs for server applications. In addition, thicker PCBs with a complex mix of components and connectors will likely increase the temperature exposure closer to 260C. For this higher temperature compatibility, PCB suppliers have yet to demonstrate the reliability required for server applications.

Still today, some temperature sensitive components and connectors cannot withstand Pb-free reflow profiles for complex and larger PCB assemblies without impact to their electrical function or long term reliability. Some temperature induced damage, such as delamination, dimensional instability and local melting, is immediate and captured in the manufacturing process. Of greater concern are the time dependant failure modes. These are not detectable during PCB or system assembly manufacturing processes, but can lead directly to system failures in the field. A new industry standard, J-STD-075, was recently released to facilitate the identification, classification, and handling of temperature sensitive components [30].

In addition, more process development work, PCB surface finish evaluations, and production experience are required to fully optimize wave solder and PTH rework for the thicker PCBs used in server systems [31]. These thicker PCBs exacerbate concerns such as copper dissolution of the PTH plating, insufficient solder fill of the PTH barrels and the longer direct exposure to the solder bath of a replacement component during rework, especially those components and connectors that are classified as 'Temperature Sensitive' for initial attach. Rework processes have typically not been evaluated by their suppliers.

Other soldering applications that still require development and qualification activities before lead-free alternatives can be successfully implemented for use within complex server systems include high performance cable assemblies and advanced thermal solutions such as small gap piston cooling hardware and vapor chamber heatsinks.

Based on all of these considerations, the position paper recommended that new entry level and mid-level complexity designs could successfully use lead-free assembly by 2012. Additional time, however, was considered to be required for redesign or phase-out of legacy low to mid-complexity products and would take until 2014. Finally, it was recommended to maintain the exemption for high end servers through 2016.

Flip Chip Exemption

An industry working group also gathered input and developed a position paper documenting the continued need for the flip chip exemption [32]. The working group concluded that it is unlikely that the total elimination of lead (Pb) in flip chip packaging for all new products could occur prior to 2014-2016. Highlighted concerns included solder joint reliability, particularly for large chips, and electromigration, particularly for high performance applications.

The other area of concern that was highlighted is the interaction between the dielectric layers within the silicon device, the solder bump, and the intermediate metallization layers. Co-development of these materials is required to prevent unacceptable damage to the dielectric layers. The older silicon fabrication process design rules and package designs were not optimized for higher stresses that exist in packages with lead-free bumps. For this reason, it was highlighted that previous generation silicon technologies might never be compatible with lead-free flip chip bumps.

Consultant Report

After the initial working group positions were submitted, a dialog was established with the consultant reviewing the exemptions for the European Commission. For many of the exemptions, additional clarifying questions were asked with more supporting material submitted and, in some cases, expert meetings were held to discuss the issues.

One area of discussion relevant to the 'lead in solders' exemption was to propose definitions for 'entry,' 'mid-level' and 'high end' servers. As previously mentioned, the consultant report from the 2004 exemption review [4] had documented a definition of 'server' for purposes of the scope of the exemption. This definition included both a technology criterion and one or more functional criteria. To meet the technology criteria, the system must be either a Class A product with single or dual processor capability or a Class B product with a minimum of dual processor capability. In addition, the system must meet one or more functional criteria such as mission critical, high reliability or high availability applications.

Since the working group recognized a distinction in the readiness of various segments of the server market, definitions would be required if the exemption would be similarly segmented in the future. Unfortunately, the task proved too complex to define clear technical categories to distinguish industry capability for lead-free soldering, and wording would be too complex for clear understanding by the industry and enforcement of compliance.

At the conclusion of the review and discussion period, the consultant report [33] was published with expiration dates proposed for the exemptions discussed here as shown in Table 1. In addition, expiration dates ranging from 2010 to 2014 were proposed for a large number of the approximately 25 other exemptions that were reviewed.

Although not discussed previously in this paper, it should be noted that in each case the consultant recommended that the industry be allowed to 'repair as produced,' in line with the possibility given for products put on the market before July 1, 2006. The second phrase for each exemption expiration reads, "for the repair, or to the reuse, of electrical and electronic equipment put on the market before" the exemption expiration date. This allowance indicates that the exemption remains valid for the repair, upgrades and reuse of systems installed prior to the exemption expiration.

Draft Legislation

Shortly after the publication of the consultant's report, the European Commission issued a proposed decision incorporating the consultant's exemptions recommendations for review and discussion by the Waste Technical Adapation (TAC) Committee comprising Member States representatives. Given the time for review and discussion by the Member States, and for scrutiny by the European Parliament and Council, the outcome may not be finalized until mid-year 2010.

There were several changes in this draft decision from the consultant report:

- The recommended expiration date for a number of exemptions, including 7b and 15, was changed from 31 July 2014 to 1 July 2014.
- The "repair and reuse" language was omitted, awaiting the finalization of the RoHS recast.
- The exemptions were renumbered from previous issues.

No.	Current Title	Recommendation	New Wording Proposal
7a	Lead in high melting temperature type solders (i.e. lead-based alloys containing 85% by weight or more lead)	Continue with amended wording (expiry date 30 June 2013)	Lead in high melting temperature type solders (i.e. lead-based alloys containing 85% by weight or more lead) until 30 Jun 2013 and lead in such solders for the repair and reuse of equipment put on the market before 1 July 2013.
7b	Lead in solders for servers, storage and storage array systems, network infrastructure equipment for switching, signaling, transmission as well as network management for telecommunications	Continue with amended wording (expiry date 31 July 2014)	Lead in solders for servers, storage and storage array systems, network infrastructure equipment for switching, signaling, transmission as well as network management for telecommunications, until 31 July 2014, and for the repair and reuse of equipment put on the market before 1 August 2014.
11	Lead used in compliant pin connector systems	Continue with amended wording (expiry date 30 June 2010)	(11a) Lead used in C-press compliant pin connector systems until 30 June 2010, and for the repair, or to the reuse, of electrical and electronic equipment put on the market before 1 July 2010
			(11b) Lead used in other than C-press compliant pin connector systems until 31 December 2012, and for the repair, or to the reuse, of electrical and electronic equipment put on the market before 1 January 2013
15	Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit Flip Chip packages	Continue with amended wording (expiry date 31 July 2014)	Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit Flip Chip packages until 31 July 2014, and for the repair, or to the reuse, of electrical and electronic equipment put on the market before 1 August 2014

Table 1. Consultant report recommendations for the expiry of the lead exemptions discussed in this paper.

EXEMPTION PHASE OUT STRATEGY

With the seemingly inevitable expiration of certain exemptions and the reduced scope of others, a strategy must be developed to manage these changes, both logistically and technically. Numerous challenges are associated with converting data collection systems, product design, portfolio management, and supply chains to meet the proposed revisions to the RoHS Directive. The logistics requirements alone are complex enough [34] that actions must be initiated for the near-in proposed changes even prior to finalization of the revised regulations. In short, a plan must be designed to intercept expiring exemptions early. Furthermore, this plan must encompass the testing of many application specific embodiments of key, new and exemption free technologies, in order to ensure reliable, and exemption free component integration into the supply chain and relevant product portfolios. The plan must also provide these product and supply chain introductions in a timely manner that poses minimal cost to the industry. In parallel, the strategy laid out must also focus clearly on the identification of existing parts that do not claim any expiring exemptions and their validated reliability as the new technologies are integrated into these products. To that end identifying the new parts and subassemblies and tracking those similar attributes of substance and physical data, is a must as these parts enter the manufacturing systems and finally into service in the field. Maintaining this critical data is clearly an important mechanism for sustained quality and reliability, and important to the supply chain and its professionals.

Similarly other world-wide regulations must be monitored and appropriate materials content and physical attributes of system and part information maintained. To meet all global requirements, and as a continued obligation, the supply chain must react timely to supply best of breed products and parts. To that end a management system for constant monitoring of regulations must be in place to update IT infrastructure, data collection methods, manufacturing processes as well as personnel education to communicate expectations and requirements on a global basis. All of the above point to maintaining a knowledgeable communication path in the supply chain in order to ensure alignment with suppliers, business partners and product plans.

All part numbers must be reviewed to determine which exemptions have been claimed by the supplier(s). This task will be particularly difficult for any of the exemptions that are proposed to split into multiple exemptions with varying expiration dates. Any change in exemption reference number, as proposed in the draft EU document, will further complicate the documentation procedure. All exemption tracking databases will need to be updated according to this additional information that must be collected. System release and product life cycle plans will need to be closely reviewed to determine which exemptions should be allowed for each new system. To reduce mid-life changes, a system ideally will be released using only those exemptions that will be available for the duration of the system's product life.

The technology changes driven by the proposed expiration of exemptions such as the ‘lead in solders’ and ‘flip chip’ provisions require on-going development investment. System roadmaps must be drafted to eliminate reliance on these exemptions prior to the proposed expiration dates. To reduce the logistics issues associated with changing technology in already released systems, the roadmap must implement these new technologies coincident with the introduction of systems and allow sufficient time for the previous generation of systems which used the exemptions to complete a normal product life cycle. Therefore, each system producer must consider how far in advance of the proposed 2014 expiration date they will need to introduce ‘exemption free’ systems to accomplish this goal.

Preparation for the next review

The exact timing of the next review is unclear given the changes proposed to the review procedure in the RoHS recast (RoHS II) text. Rather than a review period of at least every four years as required in the current Directive, the new proposal requires that "(each exemption) shall have a maximum validity period of four years and may be renewed. The Commission shall decide in due time on any application for renewal that is submitted no later than 18 months before an exemption expires". In either case, the reviews for the ‘lead in solder’ and the ‘flip chip’ exemptions are likely to occur sometime in 2012 since that would be four years after the 2008 review and 18 months prior to the proposed July 2014 expiration. Based on a 2012 review date, system producers must prepare as if the exemption expiration is firm. Given the technical challenges remaining to fully implement lead-free soldering, the roadmap plans previously described for ‘exemption free’ systems prior to 2014 are likely to include a certain amount of risk.

As the development and qualification activities progress under the assumption of pre-2014 lead-free implementation, documentation should be maintained for the challenges encountered. Sufficient documentation of hurdles that cannot be overcome will be critical evidence for presentation at the next exemption review. If the industry should find roadblocks to full implementation of lead-free soldering, it will be critical not only to present the technical evidence, but also to be able to differentiate the segment of the server, storage or NIE that is limited by those roadblocks.

CONCLUSIONS

Considerable advances have been made in the reduction and elimination of lead (Pb) from electrical and electronic equipment throughout the supply chain and in a range of product market segments since the RoHS directive was initially enacted in 2003. Even in areas initially exempted from certain requirements, such as the allowance for the continued use of lead in solders for servers and other high reliability systems, advances have been made. In some cases, these advances rationalize the elimination of certain exemptions allowed and supported by the initial regulation and/or the first exemption review in 2004. However, multiple component, assembly process, and system integration concerns still remain that should justify the continued availability of many of the exemptions, even if the scope of some of these exemptions can be reduced.

The challenge for the industry and its technical experts is to document in clear fashion where ‘the elimination of these hazardous substances in those specific materials and components is still technically or scientifically impracticable.’ The Directive allows exemptions to continue only in those cases where health or consumer safety concerns outweigh the environmental benefits of the possible substitutions.

On-going logistics and technical activities will be required to maintain RoHS compliance during this time of exemption transition. Close monitoring of product roadmaps, the supply chain, and materials content databases will be essential to eliminate any risk of non-compliance and perturbations in product shipments.

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