Association Connecting Electronics Industries

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The Electronic Interconnection Supply Chain's Response to Öko-Institut's Recommendations for Proposed Revisions to the RoHS Directive

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A White Paper from IPC — Association Connecting Electronics Industries

Executive Summary

Öko-Institut was contracted by the European Union (EU) Commission to study the inclusion of additional hazardous substances in electrical and electronic equipment under the RoHS Directive.

Öko-Institut (Institut für angewandte Ökologie Institute for Applied Ecology, a registered non-profit association) was founded in 1977 and is located in Freiburg, Germany. The objective of the Institute is “environmental research independent of government and industry, for the benefit of society.”

In its draft report to the commission, Öko-Institut recommended the restriction of Tetrabromobisphenol A (TBBPA), the flame retardant used to provide flame retardacy to more than 80 percent of printed circuit boards and found to be safe by a comprehensive European Union Risk Assessment. In addition to TBBPA, the Institute suggests banning Hexabromocylcododecanes (HBCDD), several phthalate plasticizers and all organic compounds containing chlorine and bromine.

IPC believes the Öko-Institut recommendations **are arbitrary and lack a sound scientific basis. In addition, the recommendations also would create inconsistencies between the REACH and RoHS Directives.**

The electronics industry supply chain is hard pressed to find suitable materials to replace those targeted by environmental compliance directives. **If implemented, the recommendations will have a significant negative impact on the global electronics supply chain.**

Introduction

Article 6 of the RoHS Directive (2002/95/EC) called for a review of the RoHS Directive by 13 February 2005. In particular, the Commission is required to review the categories of equipment subjected to RoHS and the list of substances restricted under RoHS. The commission is required to present proposals to include category 8 and 9 equipment (described in Annex IA to Directive 2002/96/EC (WEEE)) in the scope of the RoHS Directive, and to modify the list of substances of Article 4(1), on the basis of scientific facts.

The Directive states that “particular attention shall be paid during the review to the impact on the environment and on human health of other hazardous substances and materials used in electrical and electronic equipment. The Commission shall examine the feasibility of replacing such substances and materials and shall present proposals to the European Parliament and to the Council in order to extend the scope of Article 4, as appropriate.”

Unfortunately, the draft report prepared by the Öko-Institut was not adequately researched. Many of the proposals in the draft report are not supported by science and do not consider all relevant technical data. Many of the proposals are impractical or unfeasible and if implemented, are unlikely to achieve their intended goals.

The following is a technical discussion of the Öko-Institut's recommendations.

The Proposed Ban on TBBPA Use

The electronics industry is particularly concerned with the proposed ban on tetrabromobisphenol(a) (TBBPA). TBBPA is used in over two-thirds of the world's electrical and electronic (E&E) appliances. The main application of TBBPA is as a reactive flame retardant in laminates for printed circuit boards.

TBBPA is the largest volume brominated flame retardant in production today and is essential to provide fire safety for electrical and electronic equipment. For example, approximately 80 percent of TBBPA is used as a reactive monomer in the production of brominated epoxy resin in laminates. Laminates are the foundation for printed circuit boards in all E & E equipment including as examples televisions, printers, and computers.

An additional 20 percent is used as an additive in acrylonitrile butadiene styrene (ABS) plastics for E&E casings. ABS is considered superior compared to other polymers for its hardness, gloss, toughness, and electrical insulation properties.

Even the European Union Risk Assessment, published in the EU Official Journal on 18 June 2008, does not support the restriction of TBBPA.

TBBPA has been thoroughly evaluated for its risks on human health and the environment as part of the EU risk assessment process. The Human Health section of the Risk Assessment was closed in 2005 with no risks identified**.**

The Environmental section of the Risk Assessment was closed in June 2007. No risk was identified for TBBPA when used as a reactive material, such as in the epoxy resins of printed circuit boards**.** In addition to the EU Risk Assessment, the study "Erarbeitung von Bewertungsgrundlagen zur Substitution umweltrelevanter Flammschutzmittel," December 2000, Environmental Ministry of Germany (which we believe was conducted by Öko-Institut) showed no risk for TBBPA as reactive component:

A local environmental risk has been identified for the additive use of TBBPA at a single plant in Europe. The EU Risk Reduction Strategy did not foresee any legislative measure to control the risk identified and recommended the EU's Integrated Pollution Prevention and Control's environmental permit as a proportionate measure.

In order to ensure the safe continued use of TBBPA, the bromine industry has started working with TBBPA users through a Voluntary Emissions Control Action Programme (VECAP).

VECAP sets new standards on chemicals management in the workplace, enhances communication between levels of the supply chain and creates awareness on substances management. This programme is operated in cooperation between producers and the supply chain. All TBBPA additive users in Europe have already committed to VECAP and have implemented it in the past two years.

Impact of the Proposed Ban on TBBPA

A ban of TBBPA as reactive component to produce flame retarded epoxy systems will have a tremendous impact on the electronic industry in Europe**.**

While the largest laminate suppliers do offer TBBPA-free and halogen-free laminates today because of special market demands, the current production capacity for halogen-free resins is by far too small to cover the full demand.

Some halogen-free base material grades are available which rely mainly upon a phosphorous modified epoxy in combination with Al $(OH)_3$ to provide flame retardancy. Risk assessments of the phosphorous components have not been sufficiently carried out. In addition, not all TBBA-modified epoxy resins can be substituted by halogen-free components.

Many printed circuit board manufacturers and end users of circuit boards will also not be able to afford the significantly higher costs for halogen-free laminates. As an example:

- The substitution of TBBA-modified epoxy systems with the more expensive halogen-free systems will result in approximately *150 Mio € p.a*. ($211 million USD per year) additional costs for base material alone.

- The approval of alternative materials at printed circuit board manufacturers and OEMs will take two to five years and will cost approximately 12-15 Mio € p.a.($17 million USD to $21 million USD per year).

- Since some electrical and dielectrical properties of halogen-free materials are different, compared to those based on TBBPA as a flame retardant, it will be necessary to redesign many printed circuit boards. The total expenditure cannot be predicted.

- Halogen-free alternatives have not been developed for all cases. It will take at least five years to develop such resins and resin experts doubt that it is possible to find drop-in solutions. It is estimated that tens of millions of Euros will be needed to develop these additional resins.

The impact of the proposed ban on TBBPA will dramatically impact small and medium size manufacturers who will have much greater difficulty adapting due to lack of resources and technical skills and have little influence on suppliers.

The Proposed Ban on all Organic Compounds Containing Chlorine and Bromine

In addition to TBBPA, the report suggests banning the ill-defined category of “all organic compounds containing chlorine and bromine.” Since there are many organo-halogen substances with critical functions in electronics products, the results could cripple the electronics industry. The materials vital to the electronics industry and dramatically impacted by the proposed ban are listed below.

Impact on Electronic Grade Solder

Solder interconnections must provide electrical continuity, a thermal pathway, a hermetic seal and mechanical integrity. The solder interconnection in the electronic product contains the solder alloy along with the residues of the flux system.

Certain critical components of the solder and flux system rely on materials that could be adversely impacted by substance restrictions. For example, current formulations of plasticizers and wetting agents contain phthalates and nonyl phenol ethoxylate (NPE), both of which are targeted in the draft report. While suitable substitutes exist, reformulation of many products would be required.

Compliance with the present RoHS directive has had serious impact on small and medium manufacturing enterprises. The higher melting temperature of the lead-free alloys demanded major investments in soldering equipment and higher energy costs. The higher soldering temperatures needed for lead-free soldering combined with the maximum allowed temperature set by the components also results in a significantly narrower process window. And for the OEMs, lead-free alloys are unproven in long-term reliability in harsh environments.

Impact on Solder Fluxes

As a part of the soldering process, the creation of a solder interconnection for electronic equipment is the result of a joining process which combines a solder alloy and a flux material. Flux is a critical process material which has significant influence on the creation of sound solder joint integrity. Fluxes used for soldering most often contain organo-halides as activators.

Halogen containing activators would be significantly impacted by the Öko-Institut proposal to restrict all organo-halogen compounds. The critical step in the soldering process is cleaning the metal surfaces to allow direct metal-metal contact.

Halogens are highly effective at disrupting oxide films on solder and metal surfaces to be joined. While other activators (acids, amines) can be used to dissolve oxides, this can be too slow to compete with re-oxidation during the soldering process (up to 260°C) and the quantity of other activators that can be used is limited in solder pastes because of product stability. Generally, omitting halogen from the flux severely reduces the product process window, particularly for lead-free soldering.

The restriction of organo-halogen materials would have a severe impact on the electronic industry which is currently in the midst of a flux material evolution/substitution effort caused by the movement to lead-free solder alloys.

A ban of these organo-halides will reduce the process window even further and probably require an inert soldering atmosphere (which once again demands investment in new soldering equipment). A too narrow soldering process window will increase the number of unsatisfactory solder joints, jeopardizing the reliability of the joint and hence the finished product. As a result, electronic equipment manufacturers will face increased manufacturing costs due to increased process control needs and increased solder product scrap.

Phthalate compounds are used as non-reactive modifiers to plasticise polyurethane E & E equipment potting materials, at up to 50 percent in some formulations. Pthalates offer a unique combination of physical properties and cost. Alternative plasticisers are unproven in E & E equipment potting applications which will result in lengthy and difficult customer approval cycles.

The use of NPE in the manufacture of epoxy-based E & E equipment potting materials provides a unique combination of properties and cost. The cure/strength combination offered by these materials is not matched by commercially available alternative systems.

Organofluorine compounds, which are inherently flame resistant, are used for wire insulation, oil-free bearings and non-stick surfaces. There are no alternatives for most applications.

Impact on Parylene C and Beryllium

Another use of halogens is in coating products such as Parylene C. Parylene is currently used in implantable devices and has been in service issue free for the past 30 years.

The excellent performance of these Parylene types is due to the presence of halogens in their chemical structure. Parylene C has not shown any toxicity, and is not considered a toxic substance or pollutant. Pyrolysis of Parylene C, simulating incomplete incineration, did not create any dioxins.

It is almost impossible to replace other existing applications of Parylene C (widely used) in the market. This is primarily due to its specific properties and existing qualification requirements by the customers in the military, electronics, and automotive markets.

The medical industry will not accept a replacement material without any technical evidence that there is an issue and without a qualified alternative. Over the past 30 years, one specialty coating company has developed more than 20 molecules, but none of them could replace or provide similar properties and processing conditions of halogen containing products such as Parylene C.

The recommendation for the inclusion of beryllium/beryllium oxide is of significant concern as well. Beryllium and beryllium oxide are highly regulated and controlled materials within aviation electronics market segment. Beryllium and beryllium oxide have extensive applications for a number of electronic product applications such as:

- Electrical connectors connecting electronic systems
- Electrical components with extreme thermal management requirements
- Electronic components as leadframe materials
- Mechanical components requiring structural and thermal characteristics

- Mechanical components requiring conductivity characteristics for electromagnetic interference applications

No known substitute materials have been found for beryllium alloys which can provide the electrical, thermal, and conductive characteristics necessary to meet the requirements of the high performance electronics market segment.

Impact of the Proposed Restrictions on Critical End Uses

The High Performance Electronics Market Segment (i.e. Avionics, Military/Defense, Medical) is characterized as having life-critical, flight-critical requirements and extreme use environments which push the performance limits of the existing materials. Replacement materials often require extensive testing and evaluation programs before substitution can be permitted.

The High Performance Use Environment Industry Segment is not a "stand-alone" entity. Material changes to the global industry supply base impact all industry use segments. Like the first ROHS implementation, an expanded RoHS will be spread into industries outside the scope of the ROHS directive.

Manufacturers of long life, high-reliability products, e.g. in the energy (both old and renewable) and transportation sectors, needs to run an RoHS-compliant process (and inventory) in parallel with their mature, well established process. The suppliers in those sectors have to guarantee the operation and cannot afford to use untested processes and materials, especially for products used in transportation applications in harsh environments.

Determining, quantitatively if possible, impact of material substitutions on system safety and certification is a significant task. A critical parameter of material assessment is the balance of material elimination versus material restricted use.

Need for RoHS and REACH Compatibility

REACH (**R**egistration, **E**valuation & **A**utorisation of **Ch**emicals) is the most stringent chemical legislation in the world. Under REACH, substances with highest production volumes will be registered by the end of 2010, with other, less used substances to follow in the coming years.

Under REACH, the impact on environment and human health will be evaluated and restrictions and/or authorisation will be proposed where necessary. Those substances for which no restrictions or authorisation is found should be approved for all applications without further questioning.

The RoHS Directive should be reviewed, applying the principles endorsed by the Better Regulation Initiative, to avoid running parallel systems. We believe the European Commission should ensure total compatibility between the RoHS Directive and REACH.

TBBPA, which Öko-Institut proposes to restrict under RoHS, has been the subject of risk assessment (RA) under 793/93, with more than 200 studies performed. The recently finalized RA for TBBPA confirmed that TBBPA is not a Carcinogenic, Mutagenic, Reprotoxic (CMR), not a Persistent, Bioaccumulative, Toxic (PBT) and not a Very Persistent, Very Bioaccumulative (vPvB). The risk assessment data will be directly transferred into REACH registration dossier and is expected to be among the first substances assessed and approved by REACH.

The Öko-Institut draft report recommended restrictions on TBBPA and all halogenated compounds. This recommendation ignores the outcome of the EU Risk Assessment & Risk Reduction Strategy for TBBPA, and is an example of a lack of consistency between the results of the EU Risk Assessment and the RoHS Directive.

The restriction of Deca-BDE under RoHS is another example of RoHS incompatibility with REACH. The EU risk assessment under the Existing Substances Regulation 793/93 of Deca-BDE concluded with a positive recommendation regarding future use of Deca-BDE (on condition of further studies). DecaBDE is not a hazardous substance.

The EU needs to have complete consistency between RoHS and REACH. Thousands of companies worldwide are affected by these regulations each day. The RoHS Directive should be reviewed, applying the principles of Better Regulation and avoiding operating parallel systems. Where conclusions of risk assessment evaluations are positive, new legislation must take this into account so industry knows what to expect.

Conclusion

IPC understands and supports the need for cost-effective, science-based regulations that are protective of the public welfare and environment. The electronics industry has invested an enormous amount of time and resources to comply with existing RoHS substance restrictions and the full technical, social and cost implications of the RoHS Directive's implementation are still being discovered.

IPC is significantly concerned that Öko-Institut has arbitrarily developed a list of substances with little or no scientific basis. As detailed in this white paper, material substitutions can have far reaching effects on the supply chain.

IPC urges the European Union to avoid adding additional substances to the RoHS scope while industry, governments and the public are still facing a variety of implementation challenges.

Any expansion of the RoHS scope must be thoroughly reviewed for technical feasibility. Should the European Union deem additional substance bans to be absolutely necessary, a full life cycle assessment of the substance and its substitutes must be conducted in order to ensure that the substitution does not have unintended adverse environmental and human health impacts.

There should be clear and compelling evidence that potential substitutes are available, are reliable over the long-term and are preferable from a life cycle perspective. Until life cycle assessments are conducted proving that the environmental and human health impacts across the alternative's life cycle are better than the substances being replaced, the European Union should not restrict any further substances under RoHS.

IPC believes that any further substance restrictions beyond RoHS would more appropriately be addressed under the current REACH Directive to avoid unnecessary confusion and regulatory overlaps.

IPC urges the European Commission to supervise closely the RoHS revision process and to be mindful of the broad spectrum of stakeholders that will be impacted by any revisions to the RoHS Directive. We encourage the consideration of all relevant information during the RoHS review to ensure the best possible outcome and not contribute to further reliability concerns.

About IPC
IPC (www.IPC.org) is a global trade association based in Bannockburn, Ill., dedicated to the competitive excellence and financial success of its 2,700 member companies which represent all facets of the electronics industry, including design, printed board manufacturing, electronics assembly and test. As a member-driven organization and leading source for industry standards, training, market research and public policy advocacy, IPC supports programs to meet the needs of an estimated $1.5 trillion global electronics industry. IPC maintains additional offices in Taos, N.M.; Arlington, Va.; Garden Grove, Calif.; Stockholm, Sweden; and Shanghai, China.