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Why Europe must restrict all bromine and chlorine chemicals in electrical and electronic equipment

The European Union is about to revise the Directive on the Restriction of Hazardous Substances (RoHS). The current RoHS Directive has had a global impact in eliminating the use of certain hazardous substances including the brominated flame retardants chemicals, PBDEs, within consumer electronic products since 2003.

It is now urgent that European legislators establish a more comprehensive Directive that will protect the environment and health of workers and consumers as well as support innovation in the global electronics supply chain.

- ✓ **The revised Directive must now restrict all chlorinated and brominated chemicals in new electronic products put on the market as of 2014.**
- ✓ **In particular European legislators must urgently introduce restrictions on all Brominated Flame Retardants (BFRs) and Polyvinyl Chloride (PVC).**

The Directive's focus on the End of Life fate of chemicals is scientifically correct and further justifies why BFRs and PVC should be eliminated

The RoHS Directive is scientifically comprehensive in its approach to the regulation of chemicals in that it not only aims to protect human health and the environment but it integrates a focus on the sound recovery and disposal of electrical and electronic equipment (EEE). This life cycle approach reflects the position taken by leading companies within the electronics sector who are eliminating all bromine and chlorine substances in their components and products.[1] Companies are taking this position because of the well established scientific literature documenting the generation of brominated and chlorinated dioxins when e-waste is incinerated, burned in open landfills or otherwise subjected to thermal stress like extrusion, moulding or shredding processes. Even sunlight exposure of EEE containing organic halogenated substances is demonstrated to produce dioxins and furans[2].

E-waste end of life fate and dioxin generation is a global concern

The avoidance of halogenated chemicals by leading companies and their use of safer substitutes that do not generate persistent organic pollutants, so-called POPs, such as dioxins is transforming the global electronics supply chain. It is important that the revised RoHS Directive does not hamper the movement to safer chemicals use. Instead, **the Directive should aim to bring up the bottom and level the playing field by setting clear enforceable restrictions on brominated and chlorinated compounds in all electrical and electronic equipment.**

Furthermore, the impact that RoHS has had in triggering the introduction of similar regulations in California, China, Japan and South Korea is testimony to the importance of the RoHS Directive and its consideration of the sound recovery and recycling of WEEE.

A restriction on the use of all bromine and chlorine substances in electronic equipment will protect consumers, workers and the global community

The restriction of brominated and chlorinated organic substances will increase the reusability and recyclability of EEE as the market continues to avoid these high concern substances in recycled plastic.

The restriction of these chemicals will also protect workers in the electronics recycling industry where scientific studies have demonstrated elevated blood levels of brominated compounds in workers at Swedish recycling facilities.[3] The restriction of chlorinated and brominated compounds in new products put on the market will measurably protect consumers and children who are particularly vulnerable to these chemicals. Some phthalates which are used as plasticizers in the chlorinated polymer, PVC are classified in the EU as toxic to reproduction, recognized as Substances of Very High Concern under REACH[4], and are also Endocrine Disrupting Chemicals (EDCs) posing particular risks to the developing fetus.

Elevated blood levels of BFRs found in workers at Swedish e-waste recycling facilities

The endocrine disrupting effects of brominated flame retardants like TBBP-A are described in the scientific literature[5]. TBBP-A is widely used in EEE - about 40.000 tonnes per year in the EU alone - and has been

found in human blood-samples and human breast milk as well as in remote regions including the Arctic and in many animals, particularly those at the top of the food chain such as marine species and predatory birds. Although there remain information gaps in order to determine the official classification of TBBP-A, existing scientific research indicates that TBBP-A is very toxic to aquatic organisms; is persistent and potentially very persistent, and has endocrine disruption effects. This is particularly worrying as TBBPA is probably the largest brominated flame retardant on the market. Extremely high levels of TBBPA were found in air samples collected at a European plant involved in the recycling of e-waste, particularly in the vicinity of shredding equipment.[6] As with other brominated flame retardant chemicals, TBBPA has been found to generate dioxins during decomposition.

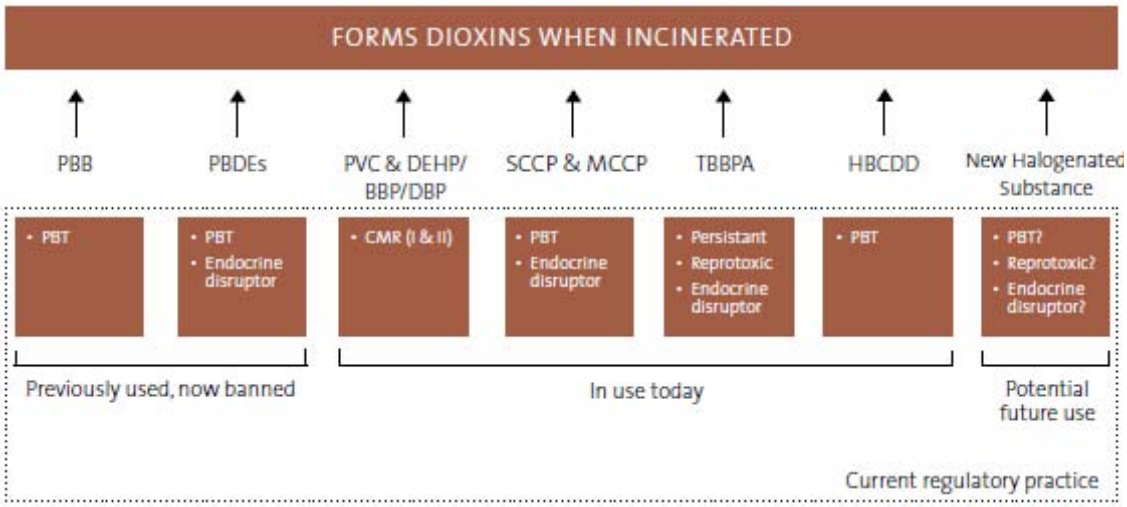
Mixed chlorinated and brominated dioxins are generated from e-waste

This brominated chemical is an example why European legislators must use the opportunity of the RoHS revision to restrict all brominated chemicals, particularly when considering the relationship of brominated and chlorinated compounds in EEE and their ability to generate dioxins and furans. Dioxins are classified as among the most toxic substances created by humans and are a priority pollutant under the Stockholm Convention for the elimination of Persistent Organic Pollutants (POPs). Indeed it is because of/due to their potential to generate dioxins that PBBs and PBDEs were restricted in the original RoHS Directive. This rationale continues to be supported within the scientific community as recent research now reveals the high levels of mixed chloro-bromo dioxins in an e-waste recycling site in China.[7]

PVC and global dioxin generation

Much of the chlorine donor for chlorinated dioxin generation comes from the use of PVC. Significant quantities (around 25-30%) of EEE waste is PVC. **Less than 10% of PVC in EEE waste is actually materially recycled due to the presence of hazardous plasticizers and additives.** The rest is incinerated. PVC may be the most significant source of chlorine for chlorinated dioxin generation globally[8]. However, the decades of scientific research which has compiled the inherent hazards of the life cycle of PVC has resulted in companies' search for safer substitutes. Suitable non halogenated flame retardants and polymers now exist as technically feasible substitutes that meet all fire safety standards. [9]

As the figure below shows, the benefit of taking a group- or class-action approach to the elimination of all chlorinated and brominated substances in new products put on the market effectively prevents the generation of dioxins at end of life.



Source: Greening Consumer Electronics: Moving Away from Bromine and Chlorine. International Chemical Secretariat and Clean Production Action. 2009

Of equal consideration is the movement away from halogenated polymers and flame retardants by companies within the global electronic sectors. The revised RoHS Directive should reflect both the scientific basis for this approach to dioxin elimination and the market demand for halogen-free, safer chemicals use. **By establishing a clear framework that restricts all bromine and chlorine chemicals in all components effective as of 2014, the Directive will support innovation by creating a level playing field within the global electronics sector and give a reliable, technically enforceable and cost effective roadmap to safer chemicals use.**

The drive for safer substitutes by companies and governments.

Within the United States, states are taking action against brominated flame retardants with a specific focus on the restriction of PBDEs. For example, the states of Washington and Maine have restricted deca-BDE based on the availability of safer substitutes and to this end have compiled extensive research on the range of alternative assessment methodologies to determine the comparative safety of substitute materials.

Tools such as the Green Screen for Safer Chemicals that use scientifically robust decision making methodologies to ensure safer substitutes are identified have now been endorsed as good decision making tools to advance safer chemicals in the economy.[10] Companies continually search for safer substitute materials and many have adopted their own internal chemical screening methods which incorporate a cradle to cradle assessment of chemicals and their degradation products.

In conclusion RoHS has paved the way as a global standard for phasing out several hazardous chemicals in the electronics supply chain. Many companies have moved beyond RoHS and there are numerous EEE products on the market today that do not contain brominated or chlorinated substances. Technical

performance and fire safety standards can now be met with readily available alternative materials and components that have been screened for comparative safety. The market demand for bromine and chlorine free products within the global electronics sector will escalate in future.

European legislators must ensure a strong revised RoHS Directive that reflects the decades of sound science documenting the inherent hazards posed by chlorinated and brominated chemicals and their ability to generate some of the most toxic compounds in existence: dioxins and furans. Failure to do so will increase the levels of these global pollutants.

Legislators can also support the commendable efforts by companies who are eliminating BFRs and PVC in the global electronics supply chain by setting clear enforceable restrictions on all brominated and chlorinated compounds in electrical and electronic equipment.

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ENDNOTES

[1] Greening Consumer Electronics: Moving Away from Bromine and Chlorine, International Chemical Secretariat (ChemSec) and Clean Production Action, September 2009. Access at: http://cleanproduction.org/Electronics.GreeningConsumer.php

[2] Dioxins can be formed by exposure to sunlight and processes of thermal stress. Ref: Kajiwara, N.;Noma, Y.; Takigami, H. Photolysis Studies of Technical Decabromodiphenyl Ether (DecaBDE) and Ethane (DeBDethane) in Plastics under Natural Sunlight. *Environ. Sci. Technol.*, 2008, *42* (12), pp 4404–4409

[3] Sjodin, A., H. Carlsson, *et al.* (2001). "Flame Retardants in Indoor Air at an Electronics Recycling Plant and at Other Work Environments." Environ Sci Technol **35**(3): 448-454 and Thuresson, K., A. Bergman, *et al.* (2006). "Polybrominated diphenyl ether exposure to electronics recycling workers - a follow up study." Chemosphere **64**(11): 1855-1861.

[4] REACH Regulation No 1907/2006, OJEU 29.05.2007. Substances of Very High Concern list: *http://echa.europa.eu/chem_data/authorisation_process/candidate_list_table_en.asp*
See the 'Priority List' and studies commissioned for European Commission's DG Environment, where 'Category 1' EDCs are listed: *http://ec.europa.eu/environment/endocrine/strategy/substances_en.htm#priority_list*

[5] Lilienthal, H., Verwer, C.M., Van der Ven, L.T.M., Piersma, A.H., Vos, J.G., 2008. Neurobehavioral effects of tetrabromobisphenol A (TBBPA) in rats after pre- and postnatal exposure. Toxicology
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Van der Ven LT, Van de Kuil T, Verhoef A, Verwer CM, Lilienthal H, Leonards PE, Schauer UM, Cantón RF, Litens S, De Jong FH, Visser TJ, Dekant W, Stern N, Håkansson H, Slob W, Van den Berg M, Vos JG, Piersma AH., 2008. Endocrine effects of tetrabromobisphenol-A (TBBPA) in Wistar rats as tested in a one-generation reproduction study and a subacute toxicity study. Toxicology

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[7] Xiezhi, Y., Zennegg, M., Engwall, M., Rotander, A. Larsson, M., Wong, M.H., Weber, R. (2008) E-waste recycling heavily contaminates a Chinese city with chlorinated, brominated and mixed halogenated dioxins. Organohalogen Compounds 70: 813-816

[8] See www.pvcinformation.org for a comprehensive collection and links to scientific studies concerning PVC's life cycle impacts and dioxin generation

[9] Greening consumer electronics. Op cit.

[10] The Green Screen for Safer Chemicals. http://cleanproduction.org/Greenscreen.php