



To the Members of the European Parliament

3 May 2001

Concerning: The 1st reading of FLORENZ reports on the Commission proposals for directives on Waste Electrical and Electronic Equipment (WEEE and Restriction in the use of certain hazardous substances in electrical and Electronic Equipment (RoHS)

Dear Members of the European Parliament,

We would like to draw your attention regarding the upcoming 1st reading in Strasbourg (15 or 16 May) on the FLORENZ reports on the proposals for directives on Waste Electrical and Electronic Equipment (WEEE) and on the Restriction of the uses of certain hazardous substances (RoHS).

This is the first EEB reaction regarding the 2 reports as adopted by the Environment Committee.

With respect to the WEEE report:

THE EEB GENERALLY SUPPORTS THE ENVIRONMENT COMMITTEE REPORT!

There are however some points for which we would like your support since they need to further be strengthened.

- **Producers should be financially individually responsible for the waste from their own future brand products!** *Support amendment 45, 1st part, Reject amendment 45, 2nd part.*
- **Producers should be financially responsible for the historical waste in a collective way, sharing the costs according to their market share.** *Follow Environment Committee proposal.*
- **The costs related to the waste management and treatment of WEEE should be internalised in the price of the product. Existing systems should adjust to such new requirements as soon as possible.** *Support amendment 17, 1st and 3^d part. Reject 17, 2nd and 4th part. Support amendment 46, 1st and 3^d part. Reject 46, 2nd part and 4th part (3a).*

Therefore

| | |
|--|----------------|
| Amendments 1 –16 | SUPPORT |
| Amendment 17, 1st part and 3rd part | SUPPORT |
| Amendment 17, 2nd part and 4th part | REJECT |
| Amendments 18 – 44 | SUPPORT |
| Amendment 45, 1st part | SUPPORT |

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|--|---------|
| Amendment 45, 2 nd part | REJECT |
| Amendment 46, 1 st part and 3 rd part | SUPPORT |
| Amendment 46, 2 nd part and 4 th part (3a) | REJECT |
| Amendments 47 – 63 | SUPPORT |
| Amendment 64 | REJECT |
| Amendment 65 – 67 | SUPPORT |
| Amendment 68 | REJECT |
| Amendment 69, 1 st part | REJECT |
| Amendment 70 | REJECT |
| Amendment 71 | SUPPORT |
| Amendment 72 | REJECT |

With respect to the RoHS report:

The EEB generally supports the Environment Committee report!

However:

There is already enough evidence on the hazardousness of heavy metals, cadmium, lead, mercury and hexavalent chromium. The same applies to all halogenated flame retardants and to gases which are ozone depleting or have a global warming potential above 15. Alternatives for these substances in EEE, providing with the same precision and safety, are already in use or are being developed. There is therefore no reason why we should continue using them, exposing the environment and human health in danger.

- **Therefore heavy metals such as cadmium, mercury, lead and hexavalent chromium as well as *ALL HALOGENATED FLAME RETARDANTS* should be phased out from use in EEE, the latest by 2006!**

**HALOGENATED FLAME RETARDANTS can generally be persistent and bioaccumulative; some may be endocrine disruptors, cause behavioural changes in mice, cause formation of dioxins and furans during incineration, are soluble in leachate from landfill, make recycling more difficult, cause higher emissions of CO during combustion and demand sometimes the use of other toxic synergists (antimony trioxide).
ALTERNATIVES EXIST and provide for the same high safety standards in similar cost.**

- **PVC and all gases which are ozone depleting substances or have a global warming potential (GWP) above 15 should also be phased out from EEE the latest by 2006.**
- **Exemptions from these provisions should be kept to an absolute minimum.**
- **Review of the exemption of the Annex should be kept under the responsibility of DG Environment.**

Therefore we would like to indicate that

Amendments 6, 16 and 20 **REJECT**

In addition please find in the attached annex further comments and justification of our position with respect to the issues debated. More detailed information can be found in "Towards Waste Free Electrical and Electronic Equipment, EEB March 2001" on www.eeb.org under "Latest publications" in English and French.

More detailed voting list will be prepared and sent to you later on.

We are looking forward to your support!

Thank you for taking our concerns into consideration.

Yours sincerely,

John Hontelez
EEB Secretary General

Annex attached
CC: Environment Attaches of Permanent Representations to the EU

ANNEX

Waste from Electrical and Electronic Equipment

Extended Producers Responsibility

The principle of Extended Producers Responsibility, has been widely accepted as one of the main instruments which corrects market failure by reconverting social costs into private ones. The producer, and hence the consumer, and not the general public - the tax payer, has to pay for the costs related to the whole life cycle of the product, including waste. Producer responsibility should also be seen as an incentive or tool for innovation, as it creates an upstream effect, which may lead to prevention and to design for the environment.

Individual versus Collective financing models for 'new' waste

It has to be underlined that it is very important that each producer takes full financial responsibility for the waste management costs of his own brand products.

- This has benefits from a legal point of view since producers can be liable only for their own products and not someone else's.
- It further ensures that free riders are avoided since the responsible company will be tracked down if costs are not covered.
- "Orphan" waste will be taken care of since in an individual responsibility model, accounting legislation requires that reserves should be built to cover the management costs of their products in case the company goes out of business.
- Individual responsibility, through the internalisation of external costs, creates a direct upstream effect which leads to design for the environment, considering the durability, reparability or upgrading, disassembly, recycling of the product, the saving of resources and eventually waste prevention.
- Organisationally speaking, individual financial responsibility allows the use of both collective and individual collection and treatment systems.

Producers responsibility for future WEEE from private households addressed through a **collective model**:

- cannot allocate concrete legal responsibility since all producers are responsible for every product (which may not even be their own),
- may fall under the ban of Article 81 (1) of the Amsterdam Treaty, as it may restrict competition in the recycling market.
- gives space to free riders, since in a voluntary collective scheme member producers cannot be made responsible for non members,
- will dilute every effort for design improvements made by an individual company.

As a result amendment 45, 2nd part, should be rejected

Visible fee

Related to the individual vs collective financial models the issue of the visible fee has also been debated.

To start with we believe that **individual producers responsibility should be seen as a** first priority compared to a collective financial responsibility model where the cost of management of WEEE to consumers is allowed or not to be shown.

The EEB believes that **there should be no visible fee** on the price of new EEE, since:

- A fee undermines individual responsibility, and gives no incentive to producers to move from a "consumer pays" approach to a "producer pays" approach.

- The fee is outside the management system of producers and thus reduces the urgency to change ongoing practices to improving the design of the product.
- A fixed fee can create market distortions, according to competition law and article 81(1) of the Amsterdam treaty, since price-fixing has been considered many times as restriction of competition.
- A fee does not necessarily create a take back incentive and can be seen as 'cancelling' the meaning of 'free-take back'.
- A fee prevents de facto a deposit that would give a further incentive to consumers to bring back their WEEE, and
- It is more likely that a fee will be considered as an extra charge, rather than a 'educational exercise' to the consumer.

Therefore amendment 17, 2nd part and 4th part and amendment 46, 2nd part and 4th part should be rejected.

Separate Collection

The EEB believes that it is very important that separate collection systems are set up and that all WEEE, including components, cables and consumables, from small and large appliances are separately collected and prohibited from being disposed of with unsorted urban waste. In this way hazardous substances, which are in WEEE will be prevented from leaching in the soil and water, and from being emitted to air in case of landfill fires. Furthermore, through the separate collection, wasting of resources will be avoided and resources within the WEEE will possibly be used. Negative impacts on the environment from the production of virgin materials as well as from landfilling and/or incineration will also be avoided.

Last holders should be allowed to return free of charge their WEEE to all producers, collection facilities and retailers, since the latter are the ones closer to the consumer.

Incentives to consumers should further be given to ensure the highest collection rate possible, such as free take back, deposit/refund schemes, easy access to collection facilities, etc.

Recovery, Reuse and Recycling targets and Treatment facilities

The waste hierarchy should always prevail when we are talking about recovery of WEEE; First reuse, then recycling and then treatment with energy recovery.

The targets proposed by the Commission should be strengthened further, should cover all product categories and reuse should further be promoted. Considering that currently the reuse of whole appliances is not part of the reuse-recycling targets, monitoring systems need to be set to ensure that collected WEEE are first checked on their possibility to be refurbished. Separate reuse targets should be set in the future. In addition the possibility to set recycling targets according to material, should further be researched.

Treatment facilities should also ensure a high level of protection of the environment and human health, not only within but also outside the EU since especially air pollution is of transboundary nature and the EU should not create dumping countries. The facilities should operate according to the Best Available Technique and should consider implementing environmental management systems.

Legal status of the directives

Finally the EEB believes that directives on WEEE and ROHS should be merged under one directive based on article 175 of the Treaty, to allow Member States to promote the protection of the environment through innovation.

Restriction of certain hazardous substances in EEE

There is already enough evidence on the hazardousness of heavy metals, cadmium, lead, mercury and hexavalent chromium. The same applies to all halogenated flame retardants and to gases which are ozone depleting or have a global warming potential above 15. Alternatives for these substances in EEE, providing with the same precision and safety, are already in use or are being developed. There is therefore no reason why we should continue using them, exposing the environment and human health in danger.

For that reason we believe that among other substances **ALL HALOGENATED FLAME RETARDANTS** should be phased out of new electrical and electronic equipment. Please see below detailed justification.

Halogenated Flame Retardants

[related extract from "Towards Waste Free EEE, EEB March 2001]

With regard to flame retardants, discussions have been focusing on whether octa-bromodiphenylether (8-BDE or OBDE) and decabromodiphenylether (10-BDE or DeBDE) should be excluded from the PBDE group and on whether we should actually extend phase-out to all halogenated flame retardants, especially the brominated ones. Apart from the two groups already proposed for phase-out, PBDEs and PBBs, other brominated flame retardants currently in use are tetrabromobisphenol A (TBBPA), which accounts for 40% of the market share and is the most important from the BFR group, hexabromocyclododecane (HBCD) (15% market share) and other BFRs (about 24% market)¹. Short-chain chlorinated paraffins are also used as flame retardant in rubbers and textiles, leather processing, in paints and coatings. Their use as a flame retardant/plasticiser may increase in the future as newer applications are exploited². In relation to the EEE, these paraffins are used in hoses and gaskets as well as in high-density conveyor belts. Short-chain chlorinated paraffins have been shown to bioconcentrate to a large extent in fish and molluscs³.

The EEB believes that all halogenated flame retardants should be phased out and consequently that 8-BDE and 10-BDE should not be exempted under any circumstances, for the reasons below. The Commission can then be asked to come up with a list of exemptions within a year of adoption of the directive.

Nearly all flame retardants containing bromine and chlorine migrate and are volatile to a certain extent.⁴ They have been found in indoor dust and air, through evaporation from end products being used, which means that they can migrate out of plastic, since most of them are added as a monomer. PBDEs and PBBs have been found in samples from living organisms in the Arctic and in remote areas like the deep sea⁵. It has also been found that these substances travel in the air over long distances. Significant losses from products being used have been observed, indicating that this is a major pathway from technosphere to environment⁶. Indications exist that these substances undergo debromination reactions to form lower brominated substances, such as tetra BDE or penta BDE which are not only persistent but also bioaccumulative and toxic⁷. Others such as TBBPA (tetrabromobisphenol A) and HBCD (hexabromocyclododecane) have been found in sewage

¹Risk Reduction Monograph n°3, OECD, 1994

² Stenhammar S. and Björndal H (1994), *Chloroparaffins in Metal Working*, Status Report No 4372. Swedish Environmental Protection Agency in co-operation with the National Chemicals Inspectorate.

³ *EU Risk Assessment Report on alkanes, C₁₀₋₁₃, chloro*, European Chemicals Bureau, December 2000

⁴ Hans Peter Hillekamps, Aluisse Martinswerk, Letter to MEP Kathleen van Brempt, 5/12/00.

⁵ Boer de, J., Wester, P. G., Rodriguez, D. P., Lewis, W. E., Boon, J. P. (1998): *Polybrominated Biphenyls and Diphenylethers in Sperm Whales and other marine mammals – a new threat to the Ocean life?* Organohalogen Compounds, Vol. 35: 383-386 (1998).

⁶ Danish EPA: *Brominated Flame Retardants. Substance Flow Analysis and Assessment of Alternatives*. June 1999.

⁷ Sellström, U., Kierkegaard, A., de Witt, C., Jansson, B. (1998): *Photolytic debromination of decabromodiphenylether (DeBDE)*. Organohalogen Compounds, Vol. 35: 447-450 (1998).

sludge⁸, fish, fish-eating birds and mammals, etc. All these substances have the potential to induce/down-regulate liver enzyme production, negatively influence the regulation of the thyroid hormone system and induce immunotoxicity (potential endocrine disrupter). They also induce neurotoxicity when administered at a sensitive period of the brain growth⁹. Exposure of neonatal mice to PBDEs causes behavioural changes in later life stages¹⁰, e.g. hyperactivity, reduced learning and memory capacity that even worsened with age. PBDE, TBBPA and HBCD are taken up by living organisms and lower PBDE biomagnify¹¹. TBBPA and PBDE and/or their metabolites have been shown to be biologically active. They can generally be persistent, bioaccumulative and toxic and also potential endocrine disrupters. In addition, dioxins and furans can be present in commercially available flame retardants and they may also be generated by recombination on the surface of ash and soot, especially when some copper is present as a catalyst¹². The problems caused by furans and dioxins during decontamination or incineration are examined further down.

In the end-of-life phase, all BFRs will be subject to thermal stress, smelting, grinding, etc. and during these operations, which can also reach a temperature of 200 degrees, the molecule cracks and free Br and free aromatic structures come into the environment^{13 14 15}. These substances, together with others such as polystyrene, form dioxins and furans, which are emitted into the atmosphere – formation of PXDF/PXDD under uncontrolled pyrolysis and incineration conditions [Luijk et al, Dumler et al, Thies et al, Bahadir]. (In general, the free halogen radius ($\cdot X$) is the trigger to all sorts of reactions.) Even controlled incineration of BFR-containing printed circuit boards in a (BAT-standard) municipal waste incineration plant leads to dioxin formation, as was observed from raised dioxin levels in incinerator fly ash¹⁶. In waste management, raised levels of octa and decaBDE have been detected in the blood plasma of recycling staff¹⁷.

During the recycling process, brominated flame retardants act as a kind of plasticizer and processing aid. This could be considered as a positive effect in the recycling process. However, they are rather ineffective in this respect and can easily be replaced by cheaper and less hazardous standard oils, plasticizers and waxes.

On the contrary, brominated flame retardants, apart from the fact that they react to brominated dioxins and furans at the raised temperature of re-extruding, as mentioned above, make the recycling of plastics more difficult as they are unwanted contaminants for many potential secondary uses. If we simplify the halogenated flame retardants to R-X, they degrade to X* (and R*) radicals. These highly reactive X* radicals react¹⁸ with hydrogen in the hydro-carbon backbone of the polymer to form hydrogen halide: $X^* + R'-H \rightarrow HX + R'^*$. There is a good chance that this reaction takes place under normal processing conditions. This will result in discolouration and reduced properties of the plastic part, especially when the polymer is processed several times. While processing virgin polymer and in order to make it survive the above conditions, thermo-stabilisers have to be incorporated. At the end of life, the polymer and the brominated flame retardant are both damaged by ozone, UV-radiation, hot/cold stress and environmental pollution. Intensive cleaning measures and additional (expensive) stabilisers are then required to achieve a tolerably acceptable

⁸ *Brominated Flame Retardants*, Swedish Environmental Protection Agency, Cynthia de Wit, 2000.

⁹ *Brominated Flame Retardants*, Swedish Environmental Protection Agency, Cynthia de Wit, 2000.

¹⁰ Eriksson, P., Jakobsson, E., Fredriksson, A. (1998): *Developmental neurotoxicity of brominated flame retardants, polybrominated diphenylethers and tetrabromo-bisphenol A*. *Organohalogen Compounds*, Vol. 35: 375-377 (1998).

¹¹ *Brominated Flame Retardants*, Swedish Environmental Protection Agency, Cynthia de Wit, 2000.

¹² Hans Peter Hillekamps, Alusuisse Martinswerk, Letter to MEP Kathleen van Brempt, 5/12/00

¹³ Lahl, U., Wilken, M., Wiebe, A. (1991): *Polybromierte Diphenylether in der Müllverbrennung*. Müll und Abfall 2/91.

¹⁴ Lohse, J. (1990): *Verhütung statt Verhüttung – bei Computerschrott ist eine emissionsfreie Wertstoffrückgewinnung ausgeschlossen*. Müllmagazin 3/1990, p. 34-37

¹⁵ Ökopol (1996): *Polybrominated Flame Retardants – a Case for Phase-out*. WWF submission to the Oslo and Paris Conventions for the Prevention of Marine Pollution (DIFF96/11/NGO.1).

¹⁶ Joachim Lohse, Ökopol GmbH, Hamburg, *The case of flame retardants – are substitutes equally safe?*, in EEB reader from Workshop on Best Practice in the context of the WEEE directive, 20/9/2000, European Parliament.

¹⁷ Sjödin, A., Hagmar, L., Klasson-Wehler, E., Kronholm-Diab, K., Jakobsson, E., Bergmann, X. (1999): *Flame Retardant Exposure: Polybrominated Diphenyl Ethers in Blood from Swedish Workers*. *Environmental Health Perspectives*, 107(8), August 1999.

¹⁸ Jürgen Troitzsch, *International Plastics Flammability Handbook*, p. 47, Hanser Publishers.

end product¹⁹. Furthermore, the hydrogen bromide or chloride generated by decomposition during incineration is highly corrosive for metal and concrete²⁰.

At this stage, we should also mention that antimony trioxide is commonly used with halogenated flame retardants as a synergist to achieve a high flame retardancy. Antimony trioxide, however, decomposes when heated, producing toxic fumes (antimony), and reacts under certain circumstances with hydrogen, producing a very poisonous gas (stibine). The substance can be absorbed into the body by inhalation, it irritates the eyes, the skin and the respiratory tract. Repeated or prolonged contact with skin may cause dermatitis. Lungs may be affected by repeated or prolonged exposure to the dust of this substance. The substance may have effects on the lungs, is possibly carcinogenic to humans and animal tests show that it may cause toxic effects upon human reproduction²¹. By replacing halogenated flame retardants, we therefore avoid its use at the same time.

These results as well as the ones that follow indicate that brominated flame retardants may be a new "PCB problem"²². It is therefore clear why brominated and to some extent all halogenated flame retardants should be phased out as soon as possible.

Regarding the more specific discussion on OctaBDE and DecaBDE, OBDE can be contaminated with Penta-BDE. Pe-BDE has been under risk assessment within the framework of chemicals legislation and has been restricted from marketing and use. It can cause secondary poisoning in the fish- and earthworm-based food chains. Risk assessment has identified risks associated with both polyurethane (PUR) foam manufacture and the use of foams. To this end, the Competent Authorities that met in November 1999 agreed that precautionary action should be taken to protect human health, given the increasing levels found in breast milk and the potential for bioaccumulation^{23 24 25 26}.

Furthermore, there are indications of accumulation and of the possible release of OBDE into milk during lactation; when milk is heated, inhalative exposures are increased. There are also possible adverse effects due to exposure to octa in utero and via milk, the endocrine disrupting activity is to be tested and there are concerns about its immunotoxic properties. These issues are being examined and are mentioned as comments for the Risk Assessment preparation from Technical Meetings under the chemicals regulation 793/93^{27 28}, but have not all been completely assessed yet. Nevertheless, the high level of concern is evident. It has been envisaged to have an indication/protection note addressed to female workers, warning them not to be exposed during pregnancy etc. for the above-mentioned reasons.

About DeBDE, similar effects and concerns have been shown. There are indications of accumulation in milk since small amounts were detected in fat, and when milk is heated, inhalative exposures probably increase. The metabolic conversion of Deca into Penta was checked and proven but in relatively small degree, and further testing is needed. Carcinogenic effects were seen at high dose levels and a reprotoxic potential needs to be checked further.

¹⁹ E-mail communication with HansPeter Hillekamps, Alusuisse Martinswerk, 23 March 2001.

²⁰ Hans Peter Hillekamps, Alusuisse Martinswerk, Letter to MEP Kathleen van Brempt, 5/12/00

²¹ International Chemicals Safety Cards, antimony trioxide, <http://www.cdc.gov/niosh/ipcs/ipcs0012.html>

²² *Brominated Flame Retardants*, Swedish Environmental Protection Agency, Cynthia de Wit, 2000

²³ Draft Commission Recommendation on the results of the risk evaluation and the risk reduction strategies for the substances: diphenylether, pentabromo derivative; cumene, 2000.

²⁴ Darnerud, P. O., Aturna, S., Aune, M., Cnattingius, S., Wernroth, M-L., Wycklund-Glynn, A. (1998): *Polybrominated Diphenyl Ethers in Breast Milk from Primiparous Women in Uppsala county, Sweden*. *Organohalogen Compounds*, Vol. 35: 411-414 (1998).

²⁵ Meironyte, D., Bergman, A., Norén, K. (1998): *Analysis of polybrominated diphenyl ethers in human milk*. *Organohalogen Compounds*, Vol. 35: 387-390 (1998).

²⁶ Norén, K., Meironyté, D. (1998): *Contaminants in Swedish human milk. Decreasing levels of organochlorine and increasing levels of organobromine compounds*. *Organohalogen Compounds*, Vol. 38: 1-4 (1998).

²⁷ RAR OBDE, Draft Risk Assessment Report for OctaBDE under Regulation EEC 793/93, November 2000.

²⁸ RAR, DeBDE, Draft Risk Assessment Report for DecaBDE under Regulation EEC/793/93, August 2000.

Moreover, for both substances, there has been evidence that they break down since the ratio of penta, octa and deca in marine environment could not be explained in many places; where a higher occurrence of OBDE and DBDE was expected, a lot of PeBDE was found, without there being any explanations by way of technological use.

Alternative strategies with respect to the construction of EEE, the choice of materials and of course the use of substitutes for halogenated flame retardants are being developed or are already applied. In this way we not only avoid hazardous substances, but safety requirements are met. An indicative list of strategies can be found below.²⁹

| | |
|------------------------|---|
| Constructive changes | geometric rearrangements (creating distance between heat sources and endangered materials) lower voltages & currents / miniaturisation --> less heat |
| Material substitution | e.g. ceramics, glass, metals instead of polymers plastics with inherently low flammability (polyamides) |
| chemicals substitution | organophosphorous compounds Ca, Al, Mg hydroxides |

Aluminium tri hydrate (ATH) and magnesium di hydrate (MDH) are two of the substances used instead of halogenated flame retardants. These are used with a relatively higher loading level in order to achieve sufficient flame retardancy. As regards their properties, both of these minerals are more or less inert. They act as acidity scavengers and the polymer is protected to a certain extent. Due to the rather high loading level, the polymer is diluted (and protected again). All recycling methods are applicable when these flame retardants are used, and in case they end up in a landfill, it should be underlined that ATH is insoluble and MDH has a very low solubility (ten times less than CaCO₃), which even has a positive influence on the acidity of the soil³⁰.

Industry has already started avoiding the use of BFRs. For example, the production of PBBs and PBDEs was stopped voluntarily in Germany as far back as 1986³¹. Some industry initiatives are described below⁷⁶.

| Industry initiatives (random selection of examples) | | |
|--|---|---------------------------|
| ZVEI Germany | Booklet on alternative strategies towards flame resistance with list of possible substitutes | 1992 |
| Siemens | Siemens Norm on product design bans PBB and PBDE from Siemens products Still problems with substitutes for certain halogen-containing components | 1994 2000 |
| German car industry | BMW ban PBB and PBDE from their products VW and Mercedes begin to use halogen-free materials for car seats and textile cover Current initiative: halogen-free cables for vehicles | 1996 1996 under way |

²⁹ Joachim Lohse, Ökopol GmbH, Hamburg, *The case of flame retardants – are substitutes equally safe?*, in EEB reader from Workshop on Best Practice in the context of the WEEE directive, 20/9/2000, European Parliament.

³⁰ Email communication with HansPeter Hillekamps, Aluisse Martinswerk, 23 March 2001.

³¹ Opinion from the Economic and Social Committee on WEEE and ROHS directives, Rapporteur Mr. Colombo, Brussels, 15 November 2000, p.7.

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| Sony | Environmental Report announces "Green Management Plan" to phase out halogenated flame retardants in European models by March 2001 and in all products sold worldwide by March 2003 ³² . | 2001 |
| Toshiba | Introduction of a notebook with halogen-free motherboard | 1999 |
| Motorola | "No technical hurdle to prevent implementation of materials which are free of lead and bromine" | 6/2000 |
| Fujitsu | Presentation of new halogen-free flame-retardant dielectric with improved properties at EGG2000+ conference | 2000 |

Further examples include BAYER development of halogen-free arylphosphate-based flame retardants for PC/ABS-Polymers used in housing and TOSHIBA argument that even notebook motherboards can be protected without the use of halogens and antimony. SONY now uses a phosphorus-nitrogen-based flame retardant system for their multilayer boards in DVD players and NEC has developed halogen-free epoxy moulding resins for components used in electronic equipment. More details on alternatives to brominated flame retardants can be found in *Alternatives to Brominated Flame Retardants, Screening for environmental and health data*, Working Report No.17 2000, Danish Environmental Protection Agency.

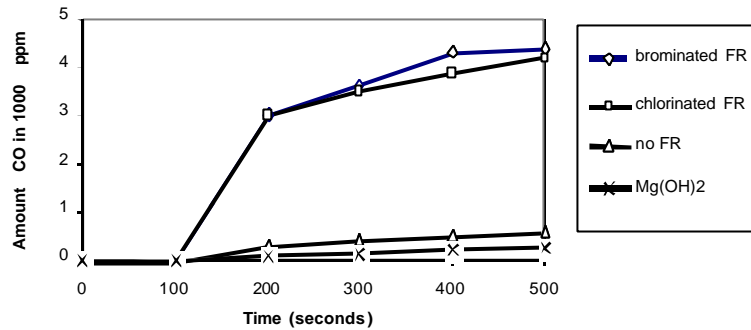
Another important aspect of using halogen-free flame retardants is their relation to the toxicity of combustion gases from the release of carbon monoxide (CO). Halogen-based flame retardants (and antimony halides) act in the gas-phase by stopping the radical reaction of the burning process. This is the main reason why much more soot and up to 10 times more CO are generated, compared with halogen-free compounds (see below). When mineral-based hydroxide flame retardants are used, there are two effects that influence the generation of CO positively:

- the rather high loading level of aluminium-hydroxide or magnesium-hydroxide, which dilutes the polymer;
- the generation of water vapour through the flame retarding reaction. The cooling effect of the water vapour influences the equilibrium in the direction of CO₂.³³

³² Progress at Sony about the elimination of hazardous substances from products, Letter from SONY, 7 March 2001.

³³ Hans Peter Hillekamps, aluisse martinswerk, *Good practice on the Substitution of Halogenated Flame Retardants*, in EEB reader from Workshop on Best Practice in the context of the WEEE directive, 20/9/2000, European Parliament.

CO-Formation of PP - Compounds with different Flame Retardants



Source: Pagliari, Cicchetti, Bevilacqua, van Hees, Paper presented at Flame Retardants 92, London

alusuisse martinswerk

Haas Peter-Hilkekampen WEEE ppt 17/09/2000

Finally, as also mentioned earlier, the EEB proposes the phase-out of all halogenated flame retardants from EEE by 2006, with the provision that the European Commission should develop an exemption list, if needed, one year after the adoption of the directive.

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