Test and Measurement Coalition

RoHS Scope Review of Category 9 Products

PBB / PBDE Dossier

1. Use of Polybrominated Biphenyls and Polybrominated Diphenyl Ethers in test and measurement equipment

1.1 General
There are 75 commercially available brominated flame retardants (BFRs) including Polybrominated diphenyl ethers (PBDEs). The manufacture of Polybrominated biphenyls ceased in May 2000.

Brominated Flame Retardants (BFRs), and flame retardants in general are extremely effective at preventing fires and in slowing the spread of fires, thus saving peoples lives and preventing severe injuries.

Flame retardants make it possible to manufacture products which meet the highest standards of fire safety in electronic equipment, construction materials, and in upholstered furniture. Many of the products containing flame retardants would otherwise present a high risk of fire, and flame retardants are very effective in reducing this risk. A room fire can very quickly escalate to the point where enough heat is generated that all combustible material in the room bursts into flames. This situation is known as "flash-over" and can occur in a matter of minutes from ignition. Flame retardants slow down the initial burn rate and thereby can help increase the time to flashover, giving the occupants more time to escape.

For example, following the UK Furniture and Furnishings Fire Safety Regulations of 1988, the addition of flame retardants to upholstered furniture has led to an estimated 1,860 lives being saved [DTI, 2000].

Flame retardants are an important safety consideration in design of electronic products. They are contained in housings, cable jackets and connectors, printed circuit boards and components. Brominated flame retardants are the most common where the base material is polymeric.

PBDEs have been largely replaced by less toxic BFRs or non-brominated materials in category 8 and 9 products. In fact no Test and Measurement Coalition members use them intentionally. Some companies have banned them contractually for several years while others use a forced exclusion process in procurement selection. Analysis of 2004 EU shipments shows none of these RoHS retardant chemicals were placed on the market by member companies.

1.2 Technical characteristics:
The goal of all flame retardants is to eliminate oxygen from combustion processes and this can be forced in several ways:

- When heated the flame retardant materials decompose through an endothermic (heat absorbing) reaction, thus reducing the energy available for fire propagation;
- Release of water (e.g. Aluminium trihydrate, borates), thus diluting the flame gases and forming an oxygen-depleted layer adjacent to the burning surface;
- Formation of pyrolysis products providing a protective layer on the surface of the burning material, preventing oxygen and heat reaching it. This can either occur through the flame-retardants own reaction to heat or by combination with the molecules of the burning material.

Brominated Flame Retardants (BFRs) are in many circumstances the most effective chemical substance, to prevent ignition or a fire from developing. BFRs are very efficient and only relatively small quantities need to be added to the material in order to provide the highest flame resistance. Therefore the intrinsic qualities of the material, such as colour, strength and durability remain intact.

Further sources of information:
http://www.cefic-efra.org/Content/Default.asp?PageID=53
http://www.bsef.com/bromine/faq/

- Trends
  Use of PBB and PBDE retardants has decreased rapidly since the substances were identified as highly bio-accumulative and regulated originally in textiles (4th amendment to the marketing and use Directive 76/769/EEC in November 1984)

- Many tested substitutes are available from suppliers of polymer and resins.

  There are no longer any special applications requiring use of PBDEs in category 8 and 9 products. Most producers have banned their use after evaluating alternatives.

2. Substitutes for (PBBs and PBDEs)

2.1. Available substitutes
The flame retardant material of choice on over 90% of all printed circuit boards is currently Tetrabromobisphenol-A (TBBPA). For other applications various possible substitutes have been employed – most are other BFRs, notable exceptions being antimony trioxide in mould compounds and alternatives for cable jackets.

Application	Polymers	Flame retardants
Laminated printed circuit boards	Epoxy & phenolic resins	TBBPA
Encapsulants for electronic components	Epoxy resins Mould compounds	TBBPA, PBDEs Other BFRs, Antimony trioxide

Housings for electrical & electronic equipment	ABS, HIPS & polycarbonate	PBDEs, TBBPA, Other BFRs
Switches, sockets & connectors	PET, PBT & polyamides	PBDEs, TBBPA, brominated polystyrene
Wire & cable insulation	PVC, EVA & crosslinked polyethylene	Alumina Trihydrate, Magnesium Hydroxide, PBDEs, Other BFRs

None of the available substitutes are currently restricted by regulation.

In addition to availability and technical performance, substitutes are chosen according to environmental impacts including end-of-life management and safety:

Environmental Impacts

Plastics containing BFRs have proven to be fully compatible with all methods of waste management, especially recycling and recovery. For example, certain plastic/BFR combinations are actually already being specified by leading manufacturers of photocopiers, in part because of their excellent stability in the recycling process.

Recycling is already taking place with 30% of some new copiers containing recycled plastic with brominated flame-retardants. A recent study concluded that ABS plastic containing a BFR was superior to other plastics in terms of recyclability and could be recycled five times in full compliance with the strictest environmental and fire safety requirements.

The Swedish company, Boliden, has developed a recycling process for electrical and electronic equipment waste, in compliance with Swedish regulation, whereby the metals are recycled.
The plastics provide some of the energy in the smelting process. BFR containing plastics have been tested in this process and fully meet the smelter's requirements.

In short, the presence of plastics containing substitute BFRs in the waste stream provides producers of many products with a wide variety of environmentally sound and economically feasible options for waste recovery and recycling.

Safety of BFRs

Penta-BDE is the only commercial BFR out of 75 to have been found in breast milk.

The World Health Organisation, as part of its International Program on Chemical Safety, undertook a full scientific assessment on the environmental and human health impacts of TBBA, the main BFR used in printed circuit boards and concluded “the risk for the general population is insignificant”.

Further sources of information:
http://www.bsef.com/publications/index.php
http://www.bsef.com/bromine/what_the_experts_say/

Selection and testing of substitutes

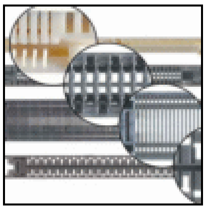
Selection of flame retardants is a complex scenario since the producer needs to find a substitute meeting the application needs. flame retardants in connector plastics have to withstand the max. temperature of assembly (260 ºC for lead-free solder or 230 ºC for convention tin-lead solder) without discolouring the plastic.

In contrast flame retardants used in wire and cable applications have extra requirements - initially, to prevent any arcing from igniting the compound, and subsequently preventing the spread of fire throughout a structure along the wiring. A cable also has the requirement to be bendable which is not a requirement of other applications in electronic products. Consequently there are many types of specialist flame retardants used in wire and cable, such as mineral flame retardants, Alumina Trihydrate (ATH) and Magnesium Hydroxide (MDH), as well as the brominated flame retardants.

Flame retardants in housings of electrical equipment may have additional performance criteria for outdoor use to ensure safety whilst having resistance to weathering effects.

Usually producers will be advised by suppliers of the most cost-effective retardant. None the less, a producer carries out a series of tests on all custom parts. These will include Electro-static discharge (ESD) as well as flammability to meet performance criteria.

Producers can also obtain advice from polymer research institutes and commercial advisor organisations such as Special Chemical Polymers. Frequently BFRs are designated by commercial trade name and it is common practise that exact formulations of RoHS compliant retardants are considered to be trade secret. The examples below illustrate the generic nature of the information available to equipment manufacturers on the chemical make-up of RoHS compliant BFRs:

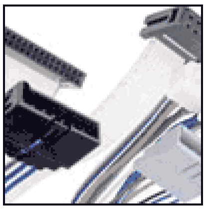


How to Improve Processability of FR **V-0** Polyamides for Thin-Walled Parts, such as Connectors?
Market: Connectors
Polymer: Polyamide

This brominated flame retardant shows superior flow properties in polymers such as Polyamide. It provides mold complex connectors and other thin-walled parts with fewer rejects and shorter cycle times.

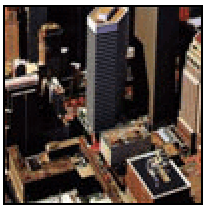
High Effective Flame Retardant for **V-0** HIPS Electronic Enclosures compliant with EU RoHS Directive.
Market: Electronics
Polymer: HIPS

This highly effective Brominated flame retardant is a excellent deca-BDE alternative compliant with EU RoHS directive and provides HIPS with good process ability and thermal stability.



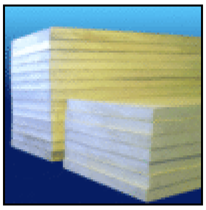
How to Improve Processability of FR **V-0** PBT for Thin-Walled Parts such as Connectors?
Market: Electronics
Polymer: PBT

This brominated flame retardant shows superior flow properties in PBT. It provides mold complex connectors and other thin-walled parts with fewer rejects and shorter cycle times.



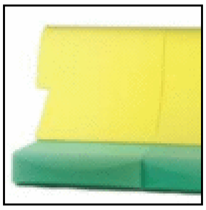
High Performance for Polyolefin Applications Requiring Excellent UV Stability or Excellent Electrical Properties
Market: Roofing and W&C
Polymer: Polyolefins

In polyolefin applications requiring flame retardancy and excellent weatherability, this Brominated flame retardant stands out as the perfect choice. Flame retardant formulations also exhibit excellent electrical performances.



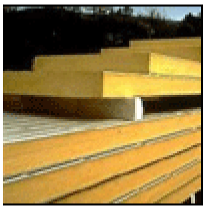
Pass **Cal TB 117** burn test decades after the flexible PU foam is produced.
Market: Furniture
Polymer: Flexible PU foam

In specific applications, there is a need for flexible polyurethane foams that not only pass the California TB117 burn test, but are also able to pass it years after the foam is produced.



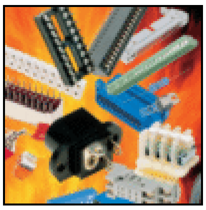
Cal TB 117 Flexible PU Foam With Uniform IFD Distribution.
Market: Furniture
Polymer: Flexible PU foam

One important aspect of conventional Cal 117 flexible foam is the load bearing property. Standard and traditional flame retardants usually contribute to a variance in IFD (hardness) values.



Excellent Physical Properties and Processability for Rigid PU foam requiring ASTM E-84
Market: Construction
Polymer: Rigid PU foam

This reactive brominated polyol is incorporated into the rigid polyurethane foam and imparts good physical properties and gives excellent flammability performance



High performance FR for PBT connectors with very low color and excellent heat stability
Market: Connectors
Polymer: PBT

In some specifc applications, color and color stability is an important criteria and it is well known that traditional flame retardants may have an impact on final color. There is clearly a need to heat stable and low color flame retardant to fulfil market requirements.

3. Impacts of substitution

3.1. Financial costs have been incurred during product development based on final product flammability testing. These are part of a standard series of safety tests carried out on final designs of any new product prior to manufacture.
The financial costs are consequently hidden in total product development costs.

3.2. There are no additional significant financial costs involved in substitution in terms of part cost or transport of compliant parts. New regulations could change this picture in future where down stream user registration of chemicals is required or labelling is needed.

3.3. WEEE provides a closed loop in terms for risk management and recycling of BFRs ensuring they should no longer enter the environment.

3.4. All substitute BFRs have some environmental impact and choice of substitute where two or more are available is based on safety performance (flammability) and environmental considerations. All available substitute substances have less environmental impact for equivalent volume. See section 2 and references.

3.5. Any new restriction to RoHS concerning TBBPA will have significant impact as there is no other available substitute.

3.6. Clearly there will be impacts on producers in order to carry out due-diligence surveys on suppliers of all potentially affected parts with a view to obtaining compliance declarations. The cost will be amortised to the extent that each part declaration will include compliance data information (absence, etc.) all RoHS substances in each part.

Another potential due-diligence impact for producers of category 8 and 9 products may be independent destructive tests for absence of PBDEs (non-destructive testing by XFR methods cannot distinguish between PBDEs and other BFRs). Today this phenomenon is a financial impact on producers of semi-conductors and producers of electronic equipment within scope of RoHS. Contracts are being amended after fighting over who pays the cost of testing. It is unclear if pressure from customers or regulatory authorities will require this expensive third party chemical testing for completed category 8 and 9 products.

4. Requests/recommendations

4.1. Exemptions

As several tried and tested substitutes are available for PBDE flame-retardants, no exemption is required for continued use of these chemicals. For most producers the impact of coming in scope of RoHS will be to check with suppliers that the restricted flame-retardants are absent and, where still in use, obtain substitute compliant parts. Custom parts such as housings and cables represent the largest potential cost of substitution. This activity is likely to take some time since the majority of parts in a product have some flame retardant material added for safety in the event of fire. We estimate the majority of large category 8 or 9 producers have over 1,000 suppliers of potentially affected parts; typically over 50,000 unique parts require verification. A transition phase-in period of three years is needed to conduct surveys with suppliers and update products where necessary to ensure compliance.