pinfa
Phosphorus, Inorganic & Nitrogen Flame Retardants Association

Your newsletter for non-halogen fire safety solutions
No. 81 June-July 2017

Modern society, industry, regulators and NGOs, are all looking for information about flame retardants for sustainable fire safety solutions with better environment and health profiles, whilst sacrificing neither fire safety nor the benefits of modern performance polymers and composites. pinfa, as the association of non-halogenated flame retardant producers and users, provides this information by participating at a range of events and conferences, as well as through our website, technical brochures and this pinfa Newsletter. This Newsletter issue refers to pinfa's participation at the Basel, Rotterdam and Stockholm conventions (COP POP), the pinfa-na workshop on fire safety in cars, the European Coatings Fire Forum. The previous edition of this newsletter summarises the AMI Pittsburgh conference on Fire Retardants in Plastics. This Newsletter also confirms pinfa's support of our mother-organisation CEFIC (the European Chemical Industry Council) recent positions confirming commitment to the Paris agreement on climate change and celebrating 10 years of implementation of the European Chemical Regulation REACH.

London Grenfell Tower fire

pinfa member companies and cefic share the grief of all those impacted by the Grenfell Tower fire tragedy, 14th June 2017. As we write, at least 79 people are known to have been killed and 127 families have lost their homes. It is too early, and it is not our role, to say what caused this fire and why it spread so rapidly with so much smoke, and with such terrible results. Media reports have however suggested that the fire started with an electrical fault in a fridge-freezer. Reports also suggest a role in the fire development of non flame retardant polymer foam thermal insulation external cladding panels, reported to be 4-6 mm non flame retardant polyethylene in aluminium sandwich and polyisocyanurate (PIR) boards used in a recent refurbishment. Media suggest that the use of non-FR panels led to a cost saving of UK£ 5 000 in the nearly 9 million £ refurbishment. The burning of these panels is visible in photos and videos. UK Government representatives 18 June 2017 and other reports indicate that these panels were not conform to applicable regulations. Panels on other UK tower buildings are now being tested, and reports indicate that all 60 buildings checked to date have failed, with over 500 yet to be verified. The fire risks of non FR or inappropriately used polymer foam cladding panels have already been highlighted by a number of recent major fire incidents (see e.g. pinfa Newsletter n°75). However, it is not known today to what extent the burning of these panels ./…

…/. contributed to the development from the fire source to catastrophe. The official enquiry should clarify whether fire safety regulations were adequate for this type of building and renovation, and whether existing fire safety regulations were respected, both as regards the cladding materials used and as regards other questions such as sprinklers, gas supply, fire stops, emergency exits. Every effort should be made to understand why this fire developed so fast and caused so many deaths, in order to do everything possible to prevent such horrific fires occurring in the future, in the UK or elsewhere.

Media sources: http://www.telegraph.co.uk/news/2017/06/23/hotpoint-fridge-freezer-sparked-grenfell-tower-fire/
http://www.abc.net.au/news/2017-06-17/grenfell-tower-panels-not-suitable-for-tall-buildings/8627790
https://www.theguardian.com/uk-news/2017/jun/18/cladding-on-grenfell-tower-banned-in-uk-says-philip-hammond
https://www.theguardian.com/uk-news/2017/jun/21/grenfell-tower-16-council-inspections-failed-to-stop-use-of-flammable-cladding?
http://www.telegraph.co.uk/news/2017/06/25/60-tower-blocks-have-now-failed-cladding-fire-safety-test-grenfell/

La Triveneta Cavi www.latrivenetacavi.com

EU consultation on abolition of building safety rules

The European Commission has opened a public consultation on the Construction Products Regulation (CPR), open online to 18th July 2017, proposing policy options including repealing the Regulation, modifying it, or maintaining it as is. At present, the CPR defines EU harmonised standards for construction products, and Member States or other regulators, architects, building companies can then specify what level of EU standard is required for products to be used in different applications. For example, the CPR defines different levels of fire resistance and smoke emission for construction products and national or city regulators can then specify what level is required in different types of building (e.g. for external or internal application, public or private building, high rise …). The CPR is fully applicable since July 2013 (less than 4 years) and the current consultation is based on a Commission report (11 pages) on its implementation, dated July 2016. This report notes that Member States have been slow to bring their construction regulations into compliance with the CPR and that harmonised European standards still need to be developed or updated for some concerned construction products, but that 75-80% of construction products are already today covered by such standards. This report concludes that not all the CPR objectives have yet been obtained after only a short period of implementation, that further guidance on implementation is necessary, that standards development processes should be streamlined and that certain articles of the CPR would benefit from clarification (page 11). The "Inception Impact Assessment" specifically submitted to the current public consultation refers to this report and points to incomplete/imperfect uptake of CPR harmonisation rules by Member States. Several policy options are submitted to consultation: maintain the CPR "as is" with efforts on flexible and uniform interpretation; adjust the CPR to take into account the above report proposals; profoundly revise the CPR for example to remove harmonisation for some products or to replace product specification by building performance approaches; or to repeal the CPR with no replacement EU regulation. **Any company, organisation or individual can respond online to this consultation which is open to 18th July 2017**, by submitting a 4 000 character free text and/or a PDF document, to express your opinions concerning the importance of the CPR to and your proposals for improving building fire safety in Europe. pinfa is preparing a response to the public consultation,

and also is active via the EU Commission's Technical Platform Meeting on the CPR Review.

EU public consultation "Review of the Construction Products Regulation", open to 18th July 2017 http://ec.europa.eu/info/law/better-regulation/initiatives/ares-2017-3070078_en

European Commission report 7th July 2016, COM(2016) 445 final, "on the implementation of Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products …" http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=8869&lang=en

pinfa high-level presentation at UNEP POP convention

Over 120 visitors met pinfa at the United Nations Environmental Program (UNEP) conference of the parties of the Basel, Rotterdam and Stockholm conventions on Persistant Organic Pollutants (COP POP), April 2017. pinfa had a stand in the innovation fair, presenting the range of different flame retardants, underlining the contribution of flame retardants to fire safety and explaining that non-toxic and non-POP PIN FR solutions are available. Rolph Payet, Secretary of the Conventions, and UNEP came to the pinfa booth after opening the conference, underling the importance of pro-active industry engagement. Contacts with a number of country representatives confirmed their interest in PIN flame retardant solutions with favourable environmental profiles and their concerns about recycling of plastics containing "legacy" POP FRs.

UNEP COP POP Stockholm Convention website http://chm.pops.int/

DecaBDE and SCCPs added to POPs list

The COP POP meeting, Geneva, April 2017, decided to add the brominated flame retardant DecBDE and the chlorinated flame retardant SCCP (short chain chlorinated paraffins) to the Stockholm Convention list of POPs (persistent organic pollutants) banned for production or use worldwide. Exemptions were granted for a number of years for specific applications, e.g. DecaBDE in cars and aircraft. The Convention decisions apply automatically to many countries worldwide (including the EU) but only for some other countries if these decide to "opt in" (e.g. China, India). The Convention's expert committee also recommended to eliminate POP brominated FRs Penta- and Octa-BDE substances as rapidly as possible from the recycling stream but the COP decided to maintain an exemption to the ban on these substances for recycled plastics.

IPEN, 1 May 2017 http://ipen.org/news/press-release-un-meeting-governments-grant-unprecedented-continued-use-toxic-chemicals-found and Stockholm Convention website http://chm.pops.int/

Dubai tightens building fire & safety code

The United Arab Emirates has published a new construction fire and safety code, including new tight regulations on flammability of building exterior claddings. This follows a number of recent fires in skyscrapers in Dubai, including Tamweel Tower 2012, Address Downtown Hotel 2015 (16 injured), Torch Tower 2015, three residential blocks 2015 and Sulafa Tower 2016 – but came before the London Grenfell Tower fire in June 2017. The new code requires all new external cladding panels to have very low flammability and includes a timeline for maintenance of panels and for replacement of non fire-safe existing panels, detailed instruction for installation and fines for non conformity. Authorities indicate that over 2/3 of the country's building fires start with

electrical faults, but that fires also start from causes outside the building, which reinforces the need for fire resistance cladding.

"Dubai toughens fire rules after tower blazes", Arab News, 22 January 2017
http://www.arabnews.com/node/1042606/middle-east

London Fire Brigade
https://www.youtube.com/watch?v=Pvko16hgJ7g

USA: electrical faults cause deadly fires

NFPA Journal reports several cases where the cause of deadly home fires is identified as electrical equipment. In one case, an overheating extension cord ignited clothing on a bedroom floor, leading to a fire which killed one occupant by asphyxiation and caused 60 000 US$ damage. Two other deadly fires were also reported to have been caused by extension leads overheating and igniting either the extension cable itself or nearby combustible materials. A further deadly fire was identified to have been caused by electrical installations setting fire to wood within a wall.

NFPA Journal March-April 2017 "Firewatch" http://www.nfpa.org/news-and-research/publications/nfpa-journal/2017/march-april-2017/news-and-analysis/firewatch

EUROPEAN COATINGS

pinfa to open European Coatings Fire Forum 2017

Philippe Salémis, pinfa Director, will launch European Coatings' "Fire Forum" 2017 (17-18 October, Berlin), with a short course on flame retardants, how they work, constraints, regulatory status and chemistries. The conference addresses fire resistant and fire protective coatings for steel, timber and other materials, including intumescent, reactive, foam and self-stratifying fire-safety coatings, many of which rely on PIN flame retardant components.

European Coatings Fire Forum, 17-18 October, Berlin http://www.european-coatings.com/Events/European-Coatings-Fire-Forum-2017/Conference-Programme

10 years of REACH positive for confidence in chemicals

Cefic has joined with ECHA and the European Commission in celebrating 10 years of REACH, the European Chemicals Regulation which entered into force on 1 June 2007. REACH is still today the main regulatory driver worldwide, according a survey of over 400 companies and 900 chemicals professionals worldwide by ChemicalWatch. A EuroBarometer survey for the European Commission (nearly 28 000 citizens interviewed face-to-face) indicates that consumer confidence in chemicals is "improving" after ten years of REACH. Nonetheless, this survey indicates that 65% of citizens are concerned or very concerned about exposure to chemicals and less than half feel well informed about the potential dangers of chemicals. 44% think that the safety of chemicals in products has improved over the last decade, compared to only 16% thinking it has deteriorated. 50% think that regulations and standards should be tightened.

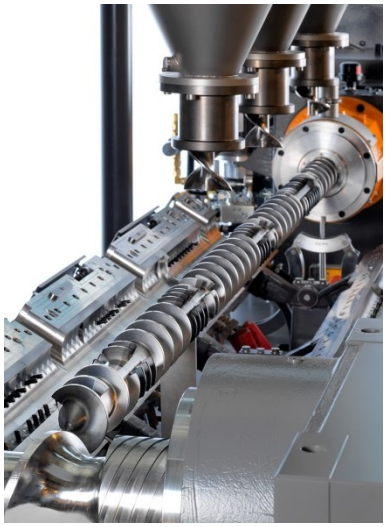
ChemicalWatch survey on regulatory drivers http://bit.ly/2qjfh4X and "Consumer confidence in chemicals improving 10 years after REACH entry into force" European Commission 8/6/2017

and full report online http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=9162

Cefic confirms commitment to Paris climate agreement

Cefic, the European chemical industry association and industry CEOs reacted immediately to Donald Trump's stated intention to withdraw from the Paris agreement. Cefic stated that it backs a strong global climate change agreement and that the European chemical industry aims to be a pillar for tomorrow's low carbon economy, with innovative chemistry supporting renewable energy, energy storage and energy efficiency, essential for the global economy as well as for the environment.

"EU chemical industry stands by its commitment to the Paris agreement" cefic 2 June 2017 http://www.cefic.org/newsroom/



Performance compounding lines for PIN FR polymers

BUSS AG, Pratteln, Switzerland, has introduced a new and upgraded version of their MX 105-22 compounder range specifically adapted for Halogen free flame retardant cable compounds. Please verify the previous statements. The new BUSS compounders are designed to optimise operation for these compounds, through mechanical simplifications which improve cost-effectiveness, energy efficiency, reliability and user accessibility to machine parts and chambers. Noise levels and space requirements are reduced. The line is available with lengths of 15 or 22 L/D, with two or three feeders, and with either a discharge extruder and retractable pelletiser or melt pump.

"Buss introduces MX-105-22 kneader at K 2016", 4th October 2016 http://www.eppm.com/k-extra/buss-introduces-mx-105-22-kneader-at-k-2016/

Fire residue chemistry from PIN FR systems

A. Sut, Berlin, PhD, 2016, analyses pyrolysis and fire residue (char) chemistry of multi-component PIN FR** systems in styrene-based thermoplastic elastomer (SEBS)* and in a DGEBA expoxy resin. Combinations of phosphorus PIN FRs with metal synergists gave good fire performance results, combining gas-phase action with generation of a graphite-like carbonaceous protective char layer. This included inorganics such as magnesium, zinc, silicon as well as aluminium phosphates, silicon dioxide. In the SEBS, a 30% loading of PIN FR combinations achieved a 85% reduction in peak heat release and UL94 horizontal burning classification. In the epoxy, a 20% PIN FR combination loading showed no loss of phosphorus in fire: the phosphorus was conserved in the minerals in the char layer.

*"Fire residues design: the chemistry behind synergistic effects in multicomponent polymeric systems", A. Sut, Freie Universität Berlin PhD thesis 2017 http://www.diss.fu-berlin.de/diss/receive/FUDISS_thesis_000000104313 * styrene-ethylene-butylene-styrene block copolymer (SEBS). ** PIN FRs used were aluminium diethylphosphinate, ammonium polyphosphate, magnesium hydroxide, zinc borate, dimethyl- and methlvinyl siloxane,*

poly(phenylene oxide), melamine poly(magnesium phosphate), boehmite, melamine polyphosphate.

Organic silicon-nitrogen based FR cellulose fibre

SOL FR® is a new inherent cellulose-based FR fibre offered by the Chinese company Beijing SOL. It is produced through spinning and solidifying after a grafting reaction between cellulose solution and new silicon-nitrogen flame retardants. Thanks to excellent thermal protection performance and small heat shrinkage coefficient of SOL FR®, the fabric can still maintain its original shape burned at a high temperature of 1100°C, playing a role as a barrier. SOL FR® is characterized with excellent flame-resistant and thermal protection performances, no melting and dripping, small smoke emission, non-toxic & non-polluting smoke and great wear comfort. In addition, it will not pollute the environment after degradation. It can be widely used in fire-fighting, military and special protective clothing industry, as well as the garments for infants and young children and the elderly, home textiles, and the interior furnishings of transportation vehicles.

http://www.solfrfiber.com/

Heat shrink tubing with PIN FRs

TE Connectivity, a global communications electronics supplier with 7 000 engineers worldwide, offers high performance PIN flame retardant heat shrinking tubing, with a 2:1 shrinkage ratio. Heat shrink tubing provides protective covering for components such as rubber hoses, plastic pipes, wiring bundles in applications such as electronics and electrical equipment, rail and transport, elevators, construction and industry. TE Connectivity's non halogen heat shrink tubings include XFFR/ZH2/ZH4, HFT5000 and HX-SCE. The use of non-halogenated PIN flame retardants enables low smoke emission and low smoke toxicity, non flame propagating and self-extinguishing, with fire resistance to standards EN45545-2 R22/R23/R24 HL3, BS 6853 Vehicle Cat 1A, NFPA 130 and NF F 16-101 Class A1. Performance properties include easy printability and print permanence, resistance to fluids, abrasion resistance and flexibility.

TE Connectivity http://www.te.com/usa-en/product-CAT-T3437-H99.html and News 13/3/2017

中国标准化研究院
CHINA NATIONAL INSTITUTE OF STANDARDIZATION

China proposed chemicals restrictions

China has carried out a public consultation on proposals to restrict 103 chemicals in consumer products, including toys, textiles, coatings, paints, decorations and furniture. The National Consumer Product Safety Standardisation Technical Commission (SAC/TC508) proposed list includes chemicals indicated in China national standards and regulations on toys, EU regulations such as REACH or food-contact plastics and Oeko-Tex standards for textiles. Amongst chemicals proposed for regulation are the halogenated flame retardants PBBs, PBDEs (other than DecaBDE) and SCCPs (short chain chlorinated paraffins), with limits of e.g. 1000 mg/kg in homogenous materials in electrical and electronic products.

Official information in Chinese http://www.cnis.gov.cn/wzgg/201703/t20170330_22259.shtml
Summary in English http://www.sgs.com/en/news/2017/04/safeguards-06717-china-proposes-to-strengthen-chemical-safety-in-consumer-products

Technical performance PIN PBTs

Lanxess High Performance Materials (HPM) division has showcased non-halogenated flame retardant performance grades of polybutylene terephthalates (PBT), with up to 30% glass fibre reinforcement. The products offer technical performance, in particular tracking and dielectrical qualities and thermal stability, and achieve glow wire test conformity and UL94 V0 fire safety at 0.4mm, enabling application in demanding electrical and electronics components. Other material properties are strength and hardness, good slip properties and high abrasion resistance, resistance to chemicals, low susceptibility to stress cracking and low moisture absorption.

Lanxess
https://techcenter.lanxess.com/scp/emea/en/products/description/55/index.jsp?pid=55

MEGOLON low smoke PIN elastomers

With over 30 years' experience in thermoplastics compounding, Mexichem is a market leader in custom-made, added-value solutions, in particular LSHF (Low Smoke Halogen Free) plastics under the MEGOLON® brand with production sites in the USA and the UK. MEGOLON LSHF (LSZH/LS0H) cable and thermoplastic compounds use PIN flame retardant technologies to achieve flame resistance whilst generating only low levels of smoke and acid fumes in case of fire. They are used in industrial, energy, power, telecom and data cables, in particular in zones where people need to be evacuated rapidly and safely in an emergency, or in areas containing expensive equipment, including hotels, high-rise buildings, exhibition centres, hospitals, subway systems, airports, communication exchanges, offshore platforms, military applications, power generation facilities, oil and petrochemical installations and many others.

http://www.mexichemspecialtycompounds.com/technologies/lshf

Artel PIN flame retardant railway hoses

Artel Rubber Company, UK, has been supplying high quality products to the rail industry for 25 years. Artel's PIN flame retardant silicone rubber hoses offer fire performance conform to railway standards and low smoke emission in case of fire. The ATH (aluminium tri hydrate) based PIN flame retardant system ensures low smoke toxicity and self extinguishing. Fire performance is UL94-V0 (3 mm) and UL94-V1 (2mm), LoI (Limiting Oxygen Index) 35% and achieves railway safety standards requirements including low toxic emissions in case of fire. Mechanical qualities include hardness, tensile and tear strength, elongation and rebound resilience. Artel rubber is a world leading supplier of silicone hoses to the rail industry, for both locomotives and coaches, as well as to the bus, coach and automotive industries.

Artel Rubber Company http://www.artelrubber.co.uk/sector/rail

Expert critical review of Sweden chemicals tax

pinfa has written to the Swedish government to support a submission by DIGITAL EUROPE, the digital technology trade organisation, raising concerns about the Sweden chemicals ecotax on E&E goods (see pinfa Newsletter n°66). An expert analysis carried out for the European electrical and electronics industry has identified over sixty problems in the Tax Act annexes likely to lead to incorrect claims and disputes, and notes the absence of standard test methods for most of the substances cited making implementation impossible. The Act will result in taxing some safer alternatives instead of more hazardous flame retardants, and so will fail to deliver the intended health and environmental objectives. DIGITAL EUROPE and pinfa ask for a sixteen month implementation delay to allow review of these issues.

Link to letter on pinfa website : http://www.pinfa.org/images/news/pinfa_Sweden_ecotax_letters_sent_11-4-17.pdf Digital Europe – IPC – ITI joint submission 31/3/2017

Other News

Dow Jones Sustainability Index (DJSI) to refer to NGO chemicals list: environmental NGO ChemSec has announced that DJSI will now require companies to specify what % of their product portfolio contains substances identified as 'hazardous' or referenced on the NGO's "Sin List". This list includes a number of brominated and chlorinated flame retardants as well as TPP (triphenyl phosphate).

"Why the stock market's increased attention on toxic chemicals is a big thing", ChemSec 30 March 2017 http://chemsec.org/why-the-stock-markets-increased-attention-on-toxic-chemicals-is-a-big-thing/

SCCPs and brominated FRs in toys: three US environmental NGOs analysed 60 children's toys purchased in ten countries worldwide, finding SCCPs (short chain chlorinated paraffins) detectable in nearly half the toys (at concentrations 8 – 20 000 ppm). Six products exceeded EU limits for SCCPs. The NGOs point out that SCCPs have been recommended by the Stockholm Convention expert committee for a world-wide ban (note: and have now been banned under the convention, see above). In a second study published in parallel, 111 toys from across the world were analysed for PBDEs and HBCD, finding these detectable in 90% of the toys, including OctaBDE and HBCD (which are listed in Annex A of the Stockholm Convention) at levels > 50 ppm in nearly 40% and >100 ppm in 7% respectively. The NGOs sugget that the presence of these FRs can result from inappropriate disposal of wastes containing "legacy" FRs.

"Toxic industrial chemical recommended for global prohibition contaminates children's toys", IPEN, ACAT, ARNIKA, 19 April 2017 http://ipen.org/news/press-release-children's-toys-contaminated-toxic-industrial-chemical-recommended-global and "POPs recycling contaminates children's toys with toxic flame retardants" IPEN, ACAT, ARNIKA, 18 April 2017 http://ipen.org/news/press-release-recycling-contaminates-plastic-children's-toys-toxic-chemicals-electronic-waste

Dechlorane Plus proposed for REACH restriction. The UK and ECHA (European Chemical Agency) have proposed that the chlorinated flame retardant Dechlorane Plus be considered for designation as SVHC (Substance of Very High Concern) under REACH, suggesting that it is vPvB (very persistent and very bioaccumulative).

ECHA "Current SVHC intentions" https://echa.europa.eu/registry-of-current-svhc-intentions

Organophosphorus FRs show long-range atmospheric transport: Samples of ocean sediments in the Arctic were assessed for seven organophosphate ester flame retardants, showing presence of some at levels comparable to levels of brominated FRs. The P-FRs were also detected in arctic air. The halogenated P-FRs show generally higher concentrations, and longer range transport. All of these phosphorus FRs are broken down within a few days in sunlight. The authors suggest that their long-range transport may result from absorption to particles in air which protect them from sunlight and enable long range transport despite their not being POPs as defined by the Stockholm convention.

P-FRs tested: three halogenated OPEs [tris(2-chloroethyl) phosphate (TCEP), tris(1-chloro-2-propyl) phosphate (TCPP), and tris(dichloroisopropyl) phosphate], three alkylated OPEs [triisobutyl phosphate (TiBP), tri-n-butyl phosphate, and tripentyl phosphate], and triphenyl phosphate. "Organophosphate Ester Flame Retardants and Plasticizers in Ocean Sediments from the North Pacific to the Arctic Ocean", Y. Ma et al., Environ. Sci. Technol. 2017, 51, 3809−3815 http://dx.doi.org/10.1021/acs.est.7b00755

French newspaper attacks bromine and flame retardants: In a first article, Le Monde suggests that "all plastics are poisoned by bromine". This points to a recent French INERIS report on the difficulties faced by the waste management sector to implement the 2005 WEEE Directive, and which proposes classification of sorted E&E waste depending on levels of bromine: >2000mg/kg POP (requiring destruction) or >1000 mg/kg possible future restriction on recycling. In a second articles brominated FRs are accused of many woes (including thyroid cancer in cats) on the base of little evidence, and claims that flame retardants in furniture and textiles "have had no measurable effects" which is questionable given the absence of domestic furniture fire safety requirements in France.

"Tri et classement des plastiques des déchets d'équipements électriques et électroniques" INERIS 16/3/2017 http://www.ineris.fr/centredoc/rapport-ineris-drc-17-164547-01461b-tri-classement-deee-vf2-1490008027.pdf Le Monde "Les déchets électroniques empoisonnés au brome" 10/4/2017 and "Une brève histoire du brome" 18/4/2017.

PBDEs accused of link to thyroid cancer: Heather Stapleton et al., Duke University USA, are reported in media as suggesting a link between exposure to the halogenated flame retardants PBDEs and TCEP and a 7% per year increase in papillary thyroid cancer in the USA over the last two decades. The study is based on only 140 patients (with and without cancer) and home dust sample analysis. Media coverage in The Mail in the UK extrapolates to suggest a link between the UK furniture fire safety regulations and a stated increase in thyroid cancer in the UK. The Times UK points to the waste disposal problem for end-of-life furniture which would result from the UN Stockholm Convention proposed classification of PBDE as POPs.

"Greater exposure to flame retardants might be associated with thyroid cancer", 3 April 2017 https://www.dcri.org/flame-retardants-thyroid-cancer/ "Your sofa can give you cancer: materials used to fireproof settees are linked to 74% rise in thyroid tumours", The Mail, 22/3/17 http://www.dailymail.co.uk/news/article-4395924/Your-sofa-CANCER.html "Toxic sofas linked to surge in thyroid cancer", Sunday Times 9/4/17 https://www.thetimes.co.uk/edition/news/toxic-fire-resistant-sofas-linked-to-surge-in-thyroid-cancer-v9zd0x537

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For abbreviations see: www.pinfa.org