Fire Retardant Technologies: safe products with optimised environmental hazard and risk performance

A research report completed for the Department for Environment, Food and Rural Affairs by GnoSys UK Ltd in association with the University of Bolton and Oakdene Hollins Ltd

November 2010

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Department for Environment Food and Rural Affairs

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Published by the Department for Environment, Food and Rural Affairs

Department for Environment, Food and Rural Affairs
Nobel House
17 Smith Square
London SW1P 3JR
Tel: 020 7238 6000
Website: www.defra.gov.uk

Information about this publication is available from:
SCP&W Evidence Base
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c/o Nobel House, 17 Smith Square
London SW1P 3JR

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SPMT09-011

Final Report to the Department for Environment, Food and Rural Affairs

November 2010

This research was commissioned and funded by Defra. The views expressed reflect the research findings and the authors' interpretation; they do not necessarily reflect Defra policy or opinions.

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TABLE OF CONTENTS

Glossary

ACHS	Advisory Committee on Hazardous Substances (Defra)
ATO	Antimony trioxide
BIS	UK Department for Business, Innovation and Skills
BEUC	The European Consumers' Organisation
CLP	Regulation on classification, labelling and packaging of substances and mixtures
C&L	Classification & Labelling
CPSC	Consumer Product Safety Commission
decaBDE	Deca Bromodiphenyl ether
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency of England and Wales
EEB	The European Environmental Bureau
EPA	Environmental Protection Agency
ESIS	European Chemical Substances Information System
FR	Fire retardant
GHS	UN Global Harmonisation System
GIF	Graphite impregnated foam
GPP	Green Public Procurement
GPSD	General Product Safety Directive
IRIS	Integrated Risk Information System
LCA	Life Cycle Assessment
NAP	National Action Plan
octaBDE	Octa- Bromodiphenyl ether
PBB	polybrominated biphenyl
PBDE	polybrominated diphenyl ether
PBT	Persistence, Bioaccumulation potential and Toxicity
PCB	Printed Circuit Board
pentaBDE	Penta Bromodiphenyl ether
PPE	Personal protective equipment
PVC	Polyvinyl chloride
REACH	Registration, Evaluation, Authorisation and Restriction of CHemicals
RoHS	Directive for the Restriction of the use of certain Hazardous Substances
TBBPA	Tetrabromobisphenol A
TCCP	Tri (2-chloropropyl) phosphate
TCPP	Tris(chloroisopropyl)phosphate
vPvB	very Persistent, very Bioaccumulative

Executive Summary

This project was commissioned by Defra as part of the Sustainable Consumption and Products programme, in support of EU Ecolabels and Green Public Procurement. The aim was to review the available technologies for achieving fire retardant properties in key product groups, and to determine best practice in terms of achieving appropriate safety standards with minimal environmental hazard and risk impact.

The objectives were to:

1. Provide a summary of the legislative landscape

2. Provide a UK and EU market analysis of key technologies used in different products

3. Review latest knowledge and risk assessments of the hazardous nature of fire retardants.

4. Undertake a review of alternative approaches to fire retardancy.

5. Provide a recommendation, for each key product group, of the fire retardancy approach with the best performance in terms of environmental hazard and risk.

6. In the light of the study findings, review whether the latest criteria set under the EU Ecolabel for (a) Textiles and (b) Bed Mattresses are fit for purpose and achievable by UK companies, and recommend overarching principles for how criteria should be set on fire retardancy in future development of standards for these and for other product groups.

The study concluded that:

1. There is significant scope to move towards design-based and inherent FR material approaches which can avoid the use of chemical FR technologies. However, adoption of these may not in all cases offer the best whole life environmental performance as judged by formal life cycle assessment and this could exclude chemical FR technologies that are good environmental performers.

2. While adoption of inherent FR technologies is to be encouraged, it may take some time for this to occur and it may be constrained by costs and other technical, environmental and market factors. It is therefore prudent to maintain Ecolabel approval of safe and low hazard chemical FR technologies that can play a role in maintaining product fire retardancy standards. This may require that existing Ecolabel criteria be reviewed and modified to enable a balanced position to be achieved which does not compromise human or environmental safety or compromise advances in fire safety that have been achieved with existing technologies.

3. Exclusion of brominated FRs is technically possible for all product groups. Such exclusion is justified for those classes of brominated FR that produce unacceptable hazards and where the application of the precautionary principle is appropriate. Exclusion based purely on possession of a certain chemical moiety cannot be scientifically justified unless there is sufficient evidence across a range of compounds to apply the precautionary principle.

4. Exclusion of chlorinated FRs is also possible for almost all product groups, although their possible substitutes in foam are not as well characterised with respect to risk and performance. However, exclusion based purely on possession of a certain chemical moiety cannot be scientifically justified unless there is sufficient evidence across a range of compounds to apply the precautionary principle.

5. The use of terms such as “reactive”, “inherent FR” or “additives” are sometimes inaccurate descriptors of the way in which some FR chemicals are incorporated or act. The modification of such vocabulary would be helpful.

6. Ensure that alternative chemical FRs to halogenated FRs are hazard assessed and their classification harmonised, and risk assessed if required, to give potential users confidence in adopting them knowing they are less hazardous than the FRs they replace.

7. Ecolabel criteria should be closely allied to the process of REACH in Europe and benefit from the hazard and risk data gathering exercises that from part of REACH for all chemical FR technologies.

8. There is general support from various industry sectors for inclusion of a flammability criterion in the EU Ecolabel.

On the question of whether the latest criteria set under the EU Ecolabel for (a) Textiles and (b) Bed Mattresses are fit for purpose and achievable by UK companies, tThe existing EU Ecolabel criteria are seen as too restrictive by both chemical FR and consumer product producers, and not consistently based on the risk phrase (regulatory hazard labelling phrases) approach to environmental performance.

Meaningful and balanced Ecolabel criteria which would encourage greater UK participation in the scheme are likely to be based on:

1. Encouragement to use non-chemical FR technologies such as through product design and inherent FR materials. For GPP this would also require that it should be achieved at reasonable cost.

2. Exclusion of any chemical FRs that are known to be hazardous through appropriate risk-phrase hazard assessment and, where appropriate, risk assessment. It is not appropriate to exclude all classes of brominated FRs due to the poor environmental performance of some classes.

3. Inclusion of chlorinated FRs that meet ecolabel hazard criteria.

4. Inclusion of both additive and reactive chemical FR types, as currently defined, but subject to other ecolabel hazard criteria. It is proposed that the use of exclusion criteria based on “reactive” and “additive” terminology ceases, and the use of such terminology in the setting of criteria should be avoided.

5. Alignment of criteria setting with REACH and CLP in Europe; this should include consideration of the effect of FRs being chemically and physically bound into materials rather than based on free molecule hazard assessments.

6. Regular review of the criteria to keep pace with hazard and risk information developments under REACH and CLP. FR chemicals should not be used in ecolabel products unless they have adequate toxicity data to ensure that no classification is required in respect of the specific risk phrases listed in the ecolabel. Absence of data and absence of classification should not mean that an FR is acceptable.

7. Include a fire retardancy criterion to ensure the fire performance of products is not compromised.

1 Context

Objectives

This project was commissioned by Defra as part of the Sustainable Consumption and Production programme[1] to support work on EU Ecolabels and Green Public Procurement. The aim was to review the available technologies for achieving fire retardant properties in key product groups, and to determine best practice for achieving appropriate safety standards with minimal environmental impact. In the context of current Ecolabel practice this relates to minimal environmental "hazard and risk" impact.

The objectives were to:

1. Provide a summary of the legislative landscape and how it has changed (including UK, EU and US developments, and covering both fire safety requirements and restrictions on substances used).

2. Provide a UK and EU market analysis to provide an insight into the key technologies currently used in different products in the UK and EU and emerging trends.

3. Undertake a review of latest scientific knowledge and risk assessment conclusions of the hazardous nature of fire retardants.

4. Undertake a review of alternative approaches to fire retardancy, including reactive technologies and physical barriers / use of naturally fire retardant materials, together with an indication of relative costs of the different approaches.

5. Provide a recommendation, for each key product group, of the fire retardancy approach with the best performance in terms of environmental impact. This would be accompanied by an assessment of the level to which this optimum approach is already employed by industry and, if applicable, the ease with which it could be taken up by the mass market and associated costs.

6. In the light of the study findings, review whether the latest criteria set under the EU Ecolabel for (a) Textiles and (b) Bed Mattresses are fit for purpose and achievable by UK companies, and recommend overarching principles for how criteria should be set on fire retardancy in future development of standards for these and for other product groups.

Scope of the project

The scope of the project relates to a selected group of products in consumer use and appropriate public use, the types of technology that can confer fire retardancy and how this is influenced by geographical differences in regulation and legislation with a focus on the UK, Europe and the United States.

The study focused on the following consumer products:

[1] www.defra.gov.uk/environment/business/scp/index.htm.

1. Products covered by the Furniture and Furnishings (Fire) (Safety) Regulations 1988: "items which contain upholstery: beds, headboards, mattresses, sofa-beds, nursery furniture" [2].

2. Clothing textiles – nightwear, personal protective equipment and any other relevant categories.

3. Electronic and electrical equipment: specifically including televisions and computers (both personal or office computers and portable computers including laptops, notebook and notebook.

The findings of the study are reported in a detailed Technical Report[3] containing four technical annexes [4,5, 6, 7]. The technical report and individual annexes are referenced in this policy centred report. It is noted that this work did not seek to critically review published risk assessment findings, or chemical classifications, and their application to the specific use of FR chemicals in the products reviewed here. This is outside the scope of the current study.

2 Conclusions and interpretation

Legislative Landscape

Fire Safety

Most of the original 12 EU Member States have nationally adopted CEN standards in place for cigarette and match testing for bedding, mattresses and seats, but few have national mandatory standards for the regulation of product fire performance. Documentary evidence has not been found of regulation in the newer Member States and it is unclear if the European Parliament will introduce legislation for the products considered in this report.

On comparing legislation and regulation in European member states it is clear that the UK has robust furniture fire safety regulations and test methods in place[4.] The Department of Business Innovation and Skills in the UK (BIS) is currently reviewing this position and has recently carried out a consultation on the UK furniture fire Regulations[2] and carried out a reappraisal of the effectiveness of the Regulations and the need for the Crib 5 test [8]. This will be used to inform decisions on the future of these Regulations. In contrast, most other

[2] HMG (1988), "The Furniture and Furnishing (Fire) (Safety) Regulations 1988", Statutory Instrument 1988 No. 1324, Consumer Protection; and, HMG (1989), "The Furniture and Furnishing (Fire) (Safety) (Amendment) Regulations, 1988, Statutory Instrument 1988 No. 1324, Consumer Protection

[3] Final Technical Report; Fire Retardant Technologies: safe products with optimised environmental hazard and risk performance, GR241 June 2010

[4] Annexe 1 Legislative Landscape, GR223, June 2010

[5] Annexe 2 Review of fire retardant risk and hazard assessment, GR230, June 2010

[6] Annexe 3 Alternative fire retardant technologies, GR233, June 2010

[7] Annexe 4 Ecolabel review and awareness study, GR256, June 2010

[8] BIS report," A statistical report to investigate the effectiveness of the Furniture and Furnishings (Fire) (Safety) Regulations 1988: GreenStreet Berman Ltd; December 2009

European countries, with some niche exceptions, rely upon the General Product Safety Directive.

The UK also has robust nightwear safety regulations and test methods in place and the Netherlands has adopted this. Some other European countries seek to prohibit highly flammable nightwear and related textiles but others rely on the General Product Safety Directive (GPSD).

The UK, along with other member states in Europe rely on the GPSD and industry voluntary measures for the fire safety of electronic products.

The GPSD acts as a safety net to prevent the placing on the European market of dangerous products within the scope of the directive, and particularly,

a) where there are no specific safety regulations in place covering those products;
b) where those products do not comply with national safety regulations; or
c) which, even if they do comply with national safety regulations, are nevertheless considered to be dangerous.

The need for further attention to fire safety in the GPSD has been acknowledged in a report from the European Commission to the European Parliament and Council on the implementation of the GPSD [9].

Approaches to Achieving Fire Safety

Where fire safety standards exist in regulatory and legislative instruments and in European and International standards, there is no requirement to use chemical FR technologies; any technology may be used as all standards are fire performance related. There are a variety of chemical, materials and physical technologies that can enhance the fire performance of products in addition to the use of design approaches which may avoid the use of chemical FRs. These technologies are reviewed and their relative environmental performance considered in Annexe 3 – they include:

1. Chemical fire retardants which are incorporated into thermoplastic and thermosetting polymeric materials and fibres as either additive or reactive technologies. These may operate as fire and flame retardants in the gas phase inhibiting or quenching fire development or as fire retardants in the solid phase by containing or restricting the availability of fuel to the fire arising from the decomposing polymer. Examples include brominated FRs which may be further enhanced using a synergist such as antimony trioxide forming an FR system that is very effective in the gas phase, or an organophosphorous FR that may operate mainly in the solid phase by encouraging char formation. Examples of these are shown in Tables 1 and 2 of Appendix A.

   It is important to note that chemical FRs may be physically or chemically bound into or onto the polymer material or fibre of interest and this will generally influence their

[9] Report from the EC to the European Parliament and Council on the implementation of the GPSD (2001/95/EC), http://ec.europa.eu/consumers/safety/prod_legis/docs/report_impl_gpsd_en.pdf

availability to escape into the environment. Risk assessment requires that exposure is assessed and this will be affected by the degree to which the FR can be retained by the material. Additive FRs will be physically bound but may be able to diffuse out of the material. In contrast, reactive FRs will usually react with the polymer matrix and undergo chemical change, so molecularly they will no longer be available as the original FR molecule. However, in practice it is not always possible to fully react such FRs and small amounts of the original FR or some by-product of the reaction may be available for release.

2. Materials technologies having different degrees of intrinsic or inherent fire retardancy are measured by common materials fire test methods. In this case the fire performance may be influenced by both the chemistry and physical and thermal stability of the material and its propensity, or not, to melt and flow during exposure to fire conditions. Hence, it is important to differentiate materials performance from product performance.

3. Product design may also be used to influence fire performance. This may include the selection and use of materials alongside other components such as physical and thermal barriers, coatings and layer technologies, heat sinks, etc. How these components are physically placed relative to one another by design, can achieve enhanced product fire performance in relation to the expected types of ignition source and flame and fire exposure (radiant flux and the transfer of heat by convection and conduction).

Annexe 3 discusses in detail and the Technical Report summarises these alternative FR technologies. As also discussed in these reports this categorisation of FR technologies also provides a simple structured approach to relative chemical hazard – such hazard will in general decrease in going from chemical FR technologies to those achieved by design (which may also include some chemical FR use, to the use of intrinsically fire retardant materials that would not need to use chemical FRs.

Chemical Safety

The current primary regulation for all chemical safety in Europe, including fire retardants, is achieved through two instruments:

1. **REACH (Registration, Evaluation, Authorisation and restriction of CHemicals)** regulation (Regulation (EC) No 1907/2006), and

2. **CLP (Regulation on Classification, Labelling and Packaging of substances and mixtures)** directive (Directive 2006/121/EC and Regulation (EC) No 1272/2008), which regulate and control the use of chemicals.

CLP and REACH place responsibility on industry to carry out the risk assessment and classification of FR chemicals [10]. Prior to this industry had primary responsibility for chemical classification and responded to legally imposed restrictions on use. Under CLP industry may impose restrictions on itself rather than waiting for legal restriction under the Market and Use of Dangerous Substances directive [11].

CLP uses a system of warnings and risk and hazards phrases to define hazard, based on the UN Globally Harmonised System of risk and hazard definitions (GHS), which then trigger risk assessment under REACH. Risk assessment is now extended beyond hazards to health, to include physical and environmental hazards, over the full life cycle of a product.

Current risk assessments for chemical FRs are summarised in Table 1 in Appendix A along with their corresponding chemical classification information, where this is publically available. Table 2 summarises the classification information available for a number of the FRs that came from the review of chemical FR technologies.

For electronic products the RoHS Directive (the Restriction of the use of certain Hazardous Substances in electrical and electronic equipment) bans the placing on the EU market of new electrical and electronic equipment containing more than agreed levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) fire retardants. The RoHS directive has prohibited the two PBDEs (pentaBDE and octaBDE) since its inception and from July 2008 decaBDE was also banned from use in electronics and electrical applications – a decision made by the European Court of Justice, not by the EC following formal risk assessment.

In Europe the primary concern in respect of decaBDE has been human health neurotoxicity and for the environment it is the degradation to lower PBDE congeners that meet the PBT/vPvB criteria. A definitive decision on its risk assessment has yet to be taken and industry has been asked to perform further studies under pre-REACH EC Regulations. However, in parallel, decaBDE came under the scrutiny of the Consumer Product Safety Commission (CPSC) and the Environmental Protection Agency (EPA) in the US who listed decaBDE for risk reassessment under the IRIS programme. However, on the 16 December 2009, the EPA announced that the three leading suppliers of decaBDE to the US had agreed to a voluntary withdrawal of decaBDE to take place over a 3 year period. At the time of producing this report.

In the UK, the most current ACHS advice is available on their website (23 September 2010) at: http://www.defra.gov.uk/environment/quality/chemicals/achs/documents/achs-decaBDE-opinion-100923.pdf. . This concludes with advice to regulators that deca-BDE has the potential to undergo environmental degradation to Substances of Very High Concern (SVHCs). The next step12 is for UK Government bodies to discuss how to progress a risk management options analysis, and a preliminary discussion will take place later in November 2010. Depending on the findings of this analysis, there may be a need to prepare

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[10] Prior to REACH it was the responsibility of member state regulators to carry out risk assessments as part of existing chemicals regulations i.e. the Dangerous Substances Directive 67/548/EEC (DSD), the Dangerous Preparations Directive 1999/45/EC (DPD), the Existing Substances Regulation (Council Regulation (EEC) No 793/93) (ESR) and the Notification of New Substances Regulations (Council Directive 67/548/EEC, last amended in 1992 as 92/32/EEC) (NONS). REACH and CLP directly replaces them, the latter two regulations having been revoked

[11] Directive 76/769/EEC on the Restrictions to Marketing and Use of Dangerous Substances

[12] Steve Dungey – private communication, 1 November 2010

an Annex XV dossier under REACH in due course, but this would be unlikely to happen until sometime during 2011.

Ecolabels and Green Public Procurement

Ecolabels

Risk phrases (regulatory hazard labelling phrases) are used in many national and international eco-labelling schemes. Risk phrases were originally developed for as-manufactured chemicals and take no account of exposure and thus risk to human health and the environment through the use of these chemical in consumer products.

The EU Ecolabel scheme follows the convention of other schemes, particularly the German Blue Angel and the Nordic Swan. Due to the lack of risk assessments on individual chemicals Ecolabels generally use the precautionary approach when defining environmental performance criteria. Risk phrases have therefore continued to be used when defining chemical criteria for additives used in a variety of products.

The current FR restrictions for the relevant product EU Ecolabels are shown in Table 1.

Table 1: Flame retardant restrictions for different product groups

EU Ecolabel Product Group	Sub-Group	Valid Until	Restrictions on Flame Retardants
Clothing[13]	Textile clothing & Accessories. Interior Textiles, Fibres Yarn & Fabric	10th July 2013	Only reactive FRs are allowed plus restriction on certain R-Phrases
Electronic Equipment	Personal Computers[14] Portable Computers[15]	31st May 2010	Plastic parts shall not contain poly-brominated biphenyl (PBB) or poly-brominated diphenyl ether (PBDE) FRs as listed in Article 4 to Directive 2002/95/EC of the European Parliament and of the Council. Also Plastic parts shall not contain chloroparaffin FRs with chain length 10-17 carbon atom Also restriction of FRs in plastic parts >25g that contain certain R-Phrases.
	TV[16]	31st October 2013	Plastic parts shall not contain poly-brominated biphenyl (PBB) or poly-brominated diphenyl ether (PBDE) FRs as listed in Article 4 to Directive 2002/95/EC of the European Parliament and of the Council. Also restriction of FRs in plastic parts >25g that contain certain R-Phrases.
Mattresses[17]	Bed	10th July	Only reactive FRs are allowed plus restriction on

[13] EU Ecolabel criteria for textile products

[14] EU Ecolabel for personal computer products

[15] EU Ecolabel criteria for portable computer products

[16] EU Ecolabel criteria for TV products

[17] EU Ecolabel criteria for bed mattresses

	mattresses, fillings for bed mattresses	2013	certain R-Phrases. Alternative hazard statements are used.

As discussed in Annex 4, the current EU Ecolabel contains exclusions for “additive” FRs in clothing and textiles where only reactive flame retardants are allowed plus restriction on certain risk phrases – these are summarised in Appendix B.

In electronic equipment, polybrominated biphenyls and polybrominated dipehnylethers and low to medium molecular weight chloroparaffins are excluded. In mattresses only reactive FRs are allowed and there are restrictions based on certain risk phrases.

Some of the issues concerned with current ecolabel criteria are:

1. Are approaches based on the use of risk phrases the most effective way to assess environmental performance.

2. Is it appropriate to exclude chemical FRs on the basis that they are “additive” rather than “reactive”.
3. Should “reactive” FRs be viewed as inherently lower hazard and risk than additive FRs.

4. Would it be appropriate to consider the exclusion of chemical classes of FR such as the organohalogen compounds combined with specific exemptions.

Green Procurement

In 2005 the European Commission published a communication outlining the need for EU Member States to implement National Action Plans (NAP) for developing Green Public Procurement (GPP). These NAPs are non-legally binding but do allow Member States to raise awareness of greener procurement of sustainable products.

The EU has developed GPP guidelines for the benefit of purchasing officials and companies wishing to tender for contracts. Of the 10 product groups that have been established, office IT equipment and textiles products are relevant to the current study and include statements regarding fire retardants. In all cases if the product has obtained the EU Ecolabel then it will automatically comply with the procurement policy. Other so-called Type 1 Ecolabels are also acceptable. So it is inevitable that the application of GPP is likely to use Ecolabel criteria and the two should be viewed as linked.

Any criteria that form the basis for Ecolabel awards or which support Green Public Procurement would be advised to align their criteria on chemical safety with that of the new CLP definitions of risk phrases and hazard statements. Consideration should also be given on the handling of chemical bans within the decisions taken under the operation of REACH in the future. However some care is required in handling policy situations that may develop over the next 2 to 5 years as REACH becomes established.

Chemical Risk Assessment and Classification

European chemical risk phrases are used in EU Ecolabel criteria for FRs. These were originally defined in Council Directive 67/548/EEC of 27 June 1967 on provisions relating to the classification, packaging and labelling of dangerous substances. This has been progressively amended and is now in its 31st amendment with current lists of risk phrases.

The current new approach to classification is Regulation (EC) 1272/2008 on classification, labelling and packaging of substances and mixtures (CLP) which entered into force on the 20 January 2009. CLP implements the Globally Harmonised System (GHS). CLP will replace Directive 67/548/EEC (substances) and Directive 1999/45/EC (preparations). The most current version is available as Regulation (EC) No 790/2009 - of 10 August 2009 - amending Regulation (EC) No 1272/2008.

In practice the so called "risk phrases" are actually "hazard phrases". It is these phrases that are used in Ecolabel criteria related to potentially harmful effects on the environmental and human health arising from exposure to fire retardants and other chemicals.

It is important to note that chemical classification (see Annexe 2) should always be supported by adequate toxicity data. It is possible for potential users of a chemical FR technology to confuse the absence of a classification with it being acceptable for use. For ecolabels this should not be acceptable and any FR that has no classification and appears to meet ecolabel requirements should have adequate toxicity data to support this position.

In December 2008 a discussion paper entitled "The path to sustainable use of chemicals in products: The European Ecolabel as a signpost" was published by The European Environmental Bureau (EEB) and The European Consumers' Organisation (BEUC) with contributions by The Oeko Institute. This discussion paper recommends that risk phrases should continue to be used in the Ecolabel scheme and also harmonise with the Global Harmonised System of Classification and Labelling of Chemicals (GHS).

Very few FRs have undergone a full risk assessment, but also very few have been classified for intrinsic hazard in accordance with the new CLP Regulations. Thus only 4 of the 30 alternatives to decaDBE, which were identified by the Danish EPA in 2006 (see of Annexe 3) have received a harmonised EU classification and only 2 of those appear in ESIS.

Substances may not be classified either because a) the substance does not meet the criteria, or b) there are insufficient data to reach a conclusion. However, this work has shown that there is some inconsistency in the way companies report on chemical classification. A classification and labelling (C&L) inventory will be compiled by January 2011 for most substances in the EU. This is expected to highlight any inconsistencies between suppliers, and data provision under REACH will allow classifications to be updated. It is important that they are also harmonised.

The absence of a chemical classification does not mean that the chemical is safe, it may indicate that the chemical has not been assessed or is in the process of being assessed.

Framework for Assessing the Environmental Performance of Alternative Fire Retardant Technologies

The starting point for the recommendations made is the existing EU Ecolabel scheme criteria. These are examined using a framework which takes a hierarchical approach to the assessment of best environmentally performing FR technologies.

This hierarchy assumes that the avoidance of FR chemicals is to be preferred to minimise human exposure and environmental impact. This can be achieved through either the use of intrinsically fire retarded materials or through designing fire retardancy into the product. This is consistent with the use of the precautionary principle applied to potential human and environmental exposure hazards associated with FR chemicals.

The FR technology hierarchy assumes in each case that the required product fire retardancy is achieved; in order of priority the hierarchy is:

Use of inherently fire retardant materials

Design of products

Use of chemical fire retardants

In turn, the human and environmental impact of chemical fire retardants can also be assessed and minimised by adopting the following hierarchy of assessment, which is linked to current Ecolabel practice:

Use of risk phrases

Prohibited and allowable chemical classes

Exemptions = where no alternative approach will enable fire safety to be maintained

White List - in which all chemical fire retardants are prohibited with the exception of named chemicals that have been incontrovertibly shown to be of very low hazard and enable fire safety to be maintained.

This approach however is in turn constrained by the following factors:

Meeting legislative requirements

Maintaining a degree of commercial choice

Cost – to the product manufacturer and the consumer

It should be noted that no attempt has been made to include any assessment of life cycle environmental performance; however such assessments could form part of a more thorough evaluation in the future.

Are Current EU Ecolabel Criteria Fit For Purpose?

To answer this question we have considered the position of each product group in regard to the current EU Ecolabel criteria and those that might be considered in the future. We have also addressed some generic issues that affect all ecolabels.

Use of Halogenated FRs

There is a drive from some retailers (see Annexe 3) in conjunction with environmental organisations to replace chlorinated FRs, but concerns are not as great about these compounds, as they are for brominated FRs. For example, some of the chlorinated phosphorus FRs used in foams are not subject to adverse risk phrases.

Generally for the non-halogenated FRs there is some uncertainty about their FR effectiveness across different polymer types. In many cases, these compounds can meet the requirements just as the halogenated FRs can, providing acceptable environmental performance, although very few have been risk assessed to date. Until this is achieved it would be perverse to exclude a compound like TCPP by over-restrictive Ecolabel criteria centred on excluding all halogen containing and additive FRs.

Blanket bans by chemical moiety or reaction mechanism

A blanket banning of specific FR product categories, such as brominated or halogenated compounds without underpinning hazard and risk assessment evidence cannot be justified scientifically. When surveyed, it was neither favoured by most of the FR manufacturers, nor by some of the product manufacturers. However there was a widespread acceptance that brominated compounds would likely not be acceptable in high-end environmentally-conscious products. There is also some movement to remove halogenated FRs and replace them with non-halogenated alternatives particularly in polyurethane foam. However, this move to improve the environmental performance may be perverse because some chlorinated FRs satisfy the risk phrase criteria and potential substitutes may be excluded solely because they are additive chemical FR technologies.

Hence whilst a potential banning of all halogenated compounds from Ecolabel textile products appears technically feasible, this is not supported by a consideration of their risk phrases. While there is mounting evidence that some brominated FRs such as the PBDEs should be withdrawn or banned, this cannot at present be generalised to all brominated FRs. An example of this is TBBPA (see Appendix B) which when reacted is considered to present no serious threat to human health and the environment and which it could be argued is strategically important to the move to lead free soldering of printed circuit boards – see Annexe 3. Nevertheless, if the process for the inclusion and reaction of reactive brominated FRs such as TBBPA is poor and the concentration of residual FR is unacceptably high, exclusion in ecolabeled products is justified. From the survey work conducted, the banning of FRs based on chemical class alone is not supported by the majority of organisations consulted.

Use of Reactive rather than Additive

The use of a reactive exclusion criterion severely limits the number of chemical FRs that could be classed as environmentally safe and such a restriction cannot be justified on hazard assessment grounds. This is shown in Appendix C where those FRs highlighted in blue all satisfy EU Ecolabel requirements but which could be excluded solely on the basis of being additive. Many survey respondents also held the view that the reactive exclusion criterion is overly restrictive – see Annexe 3.
An example of an FR being excluded on the basis of it being additive but not meeting risk phrase criteria that would exclude it is TCPP (tris (2-chloro-1-methylethylphosphate) shown in Appendix B. There are several further examples given in Annexe 4 Table 4.10.

In contrast TBBPA is acceptable because it does meet the risk phrase criteria when unreacted, it is considered not to when it is reacted. Its acceptability is then determined by the amount of residual TBBPA. This same approach could be applied to all reactive FRs and this recognises the conferring of improved environmental hazard and risk performance as a result of reactive transformation and covalent inclusion in the polymer matrix.

In general then the consideration of residual monomeric FR is decisive in assessing reactive FRs. Further examples are cited in Annexe 4 (Table 4.10).

It may also be necessary to consider products of reaction that may be produced and create an additional hazard and risk. The production of formaldehyde in the use of some reactive polyphosphonium FRs for textiles (see Annexe 3) is an example of this. This too may be subject to defined acceptable concentration limits as ecolabel criteria for those products that might be expected to contain the reaction by product.

Use of a White List

The adoption of a white list similar to that adopted by Oeko-tex was generally not favoured by textile related companies although it is broadly favoured by electronics centred companies.

Many survey respondents considered that the use of risk phrases was more flexible.

In regard to GPP thinking, restriction to the FR white list used by Oeko-tex was not believed to cause any particular cost issues, since many of the widely used FRs are on the current list.

Textiles for Clothing and Furnishings

Design and inherent FR materials approaches to fire retardancy are possible for textile products, and there are successful examples in each product category. However they lead to the restriction of choice for the consumer in some way, usually limiting the choice of covering or filling materials, or may produce an inferior less durable product in the case of personal protective equipment. This may be to an acceptable degree, for example in sleepwear, as long as a single material choice (e.g. in this case polyester) is acceptable to the consumer. In other cases it may be to an unacceptable degree, such as the inability to use conventional polyurethane foams, even those containing better environmentally performing non-chlorinated phosphorus FRs. Costs would increase in all cases, sometimes substantially so and while this is not relevant to Ecolabels it is relevant to GPP.

Sleepwear and Personal Protective Equipment

With PPE, and, to a degree, in sleepwear it may be acceptable to use an inherent FR material as long as a single material choice is acceptable to the consumer (e.g. Kevlar for PPE and polyester for sleepwear). The use of modified acrylic/ cotton mixes should be investigated to increase the range of materials available.

Appropriate review of the formaldehyde emission requirements for non-skin contact textiles could make the Ecolabel more achievable for PPE applications and allow the reactive phosphonium based FRs to continue to be used while improvements are made to reduce the potential for formaldehyde release.

Interior Furnishings including Foam and Mattresses

Inherent FR approaches are possible for many textiles, for example the use of modified acrylic/cotton blends or polyester in coverings, but they may be seen as limited within the current vast range of materials and constructions currently available. These approaches may be used for Ecolabel purposes and they could also be supported for GPP when the additional cost reasonably permits it.

The potential use of interliners as a design alternative to eliminate chemical FR use may be of limited use in gaining environmental improvement since it is believed that most interliners in the UK are made of cotton, which would require treatment with FRs. Inherently FR materials such as aramid would be possible, but would cost approximately ten times more. So while technical alternatives do exist and are good environmental performers (in risk phrase terms), their costs and market constraints may be prohibitive at this point in time. Glass fibre wrapped in inherently FR fibres is a possible solution.

The general approach to meet flammability requirements by a treated top cover (using a reactive phosphonium based FR or equivalent) and by treated foam is accepted as workable. Top cover could also be treated with ammonium polyphosphate based products, which on curing can provide soak – durable treatment. Brominated FRs in backcoated textiles have some advantages, largely around their flexibility in application but their environmental performance is poor. This has recently been recognised by suppliers of decaBDE to the US who have entered a voluntary agreement to remove this FR from use over the next 3 years.

There is also market acceptance from the survey work conducted here that current brominated FRs will be excluded from Ecolabels solely on the basis of being brominated. If market acceptance is shown to be substantial, it is recommended that brominated FRs with ATO synergists be phased out for textiles in favour of phosphorus-based FRs, and alternative synergists to ATO should be investigated.

An additional option is to use polymeric brominated, organophosphorus and other additive FRs, if their environmental performance proves to be acceptable. These may also be combined with alternative synergists.

In regard to foam fillings, the chlorinated phosphorus FR compounds are currently the primary FR technology for FR foams. However non-chlorinated phosphorus FR compounds are starting to become commercially available. These are for example being introduced into office furniture by one foam manufacturer and their introduction into interior furnishings in households should be encouraged. Similarly, fire-blocker technologies currently used in the public transport industry could be transferred to the domestic market or graphite impregnated foam (GIF), as used in the aircraft industry.

Those non-chlorinated phosphorus based chemical FR technologies which satisfy the Ecolabel risk phrase criteria, may be considered as best environmental performers. However, in regards to potential GPP requirements the potential difficulties of the costs and market acceptance of GIF-foams could be an issue. However, these FRs would not currently satisfy the Ecolabel criterion that excludes “additive” chemical FRs; this criterion would need to be modified to enable the use of such FRs. This could be made selective through the use of exceptions or white list approaches.

The Oeko-tex white list approach is considered a reasonable attempt to meet environmental criteria. However, in the interior furnishings and related component sectors there is a preference for the risk phrase approach rather than a white list approach, due to the greater flexibility that this approach provides. Similarly, a blanket ban on specific product categories is not favoured unless there is clear evidence of hazards and risks to support it.

Electronic Products

The use of inherent FR materials in casings and enclosures is possible but in regard to GPP requirements the costs may be prohibitive particularly for the high performance polymers and composites that could be used. This is not an issue for Ecolabels.

The unacceptability of decaBDE and its satisfying of the hazard criteria suggest that the exclusion of all PBDEs in the EU Ecolabel is justified. Similarly, some of the concerns expressed about ATO, indicate that while this is one of the best fire performing FR technology classes when combined with halogenated FRs, it is one of poorest environmental performers in this combination for casings and enclosures. Other additive chemical FR technologies based on phosphorus based FRs which satisfy current risk phrase criteria perform better but care is required to ensure that only those FRs that are chemically classified and shown to be satisfactory should be included. This may be achieved with an appropriate phase out strategy.

For printed circuit boards the reactive and brominated FR TBBPA satisfies the risk phrase criteria as a monomer but it would be excluded if its residual unreacted concentration in a product fails to satisfy ecolabel criteria.

The existence of inherent FR materials in high specification printed circuit boards offers the best environmental performance and this may be encouraged by ecolabels. However, in regard to GPP, the cost of adopting this technology in consumer electronic products would be prohibitive.

While the exclusion of some brominated FRs is justified on environmental grounds, such exclusions should not be applied to all brominated FRs that could be used in electronic product applications.

A number of chlorophosphorus and organophoshorous based FRs with good risk phrase based environmental performance are available which could replace brominated FRs and these should not be arbitrarily excluded.

Representatives of the electronics sector that were interviewed were sympathetic to a white list approach to FR acceptance. Technically, this is attractive as it presents manufacturers with a definite albeit limited choice of acceptable FR technologies. This would also simplify the recycling of these materials in the future.

This contrasted with the view of the textiles sector that preferred an R-phrase approach, while both sector groups preferred that exclusion should not be based on additive and chemical class exclusions – these were seen as too restrictive.

It is noted that many large product producers and retailers in both sectors appear to support the removal of all brominated FR compounds and some favour the removal of all halogenated FRs.

3 Recommendations

Sleepwear

1. For children's sleepwear which is 100% untreated polyester, the material is able to meet current Ecolabel criteria but it cannot be recommended for this application on this basis alone.

This recommendation recognises concerns over the tendency of this material to melt when heated in fire and which may cause serious burns to the wearer. While Ecolabel accept this material in regard to its environmental performance, it would reject other materials containing additive FR technologies and which perform more safely in fire. In this regard Oeko-Tex uses a white list approach to identify up to 14 environmentally acceptable FRs which significantly broadens materials choice.

2. Some FR alternatives contain halogens and these should not be excluded unless they do not meet the hazard criteria. This may require a reconsideration of halogen exclusion.

3. Maintain the limits on formaldehyde for skin contact sleepwear.

There are some FR treated cottons incorporating phosphorus or nitrogen-based FRs which are sold for children by some retailers. In this case some concerns exist in regard to skin irritation and loss of FR performance caused by numerous washes.

4. Further work is required on the use of modified acrylic/ cotton mixes and the questions raised on possible hydrogen cyanide emissions; these should not be recommended as inherent FR materials until the question has been answered.

Modified acrylic / cotton mixes which produce a partially inherent FR textile have been criticised because of possible hydrogen cyanide emissions. Until this is resolved such fibre mixtures should not be seen to reduce chemical hazards.

Personal Protective Equipment

5. Use inherent FR materials such as Kevlar and Kermel

The use of inherent FR materials is to be recommended when there are no costs constraints. Where such constraints exist or where market choice is important then chemical FR technologies will be required for use with more flammable materials.

6. In regard to the phosphonium salts:

    (a) Relax the formaldehyde limit to enable the use of phosphonium salts to fire protect cheaper textile materials.

The most commonly used durable commercial finishes are tetrakis hydroxyl methyl phosphonium chloride-urea condensate (eg, Proban, Rhodia Specialities Ltd) and N-methylol dimethyl phosphonopropionamide (eg Pyrovatex, Huntsman, formerly Ciba). However, in view of the possible release of formaldehyde, this would be more generally acceptable for non-skin contact applications.

    (b) Alternatively, exempt phosphonium salts or add FR technologies containing them to a white list

Materials treated with these FR technologies might be allowed under the current Ecolabel risk phrases if they were treated as an exemption with restrictions on use or they could be placed on a white list of approved FRs. In either case a formaldehyde emission limit could be set to achieve this.

    (c) And/or, different formaldehyde limits according to use of the material

As the formaldehyde content is a general issue for this type of treatment, an alternative approach would be to introduce a more stringent free formaldehyde content for children's sleepwear, and a less stringent requirement for garments in contact with adult skin, and less so again for garments not in contact with the skin. PPE would fall into the latter two categories, and so could be made permissible for Ecolabel and green procurement purposes.

7. Use different technologies according to the specification and intended use of the PPE

For high performance PPE applications, it is recommended that inherent fire retardant materials such as Kevlar and Kermel should be considered and phosphonium based FR technology treated fabrics be allowed for lower specification PPE by allowing the formaldehyde limit to be relaxed to a level that can be achieved for good quality treated FR finishes.

Furnishings and Furniture

FR technologies avoiding the use of chemicals

Covering fabrics from inherently flame retardant fibres

8. Use natural fire resistant materials such as wool or leather

Wool fabric of high area density, i.e. ≥ 600 g/m^2, can pass the required fire performance tests. If a lighter wool fabric is used, it might need some fire retardant treatment (e.g. by the ZIRPRO-treatment using hexafluoro zirconate or titanate by the exhaustion method) at nominal levels.

Leather is inherently fire retardant. However, artificial leather fabrics, eg, polyurethane based require a chemical fire retardant treatment to satisfy fire retardancy requirements. However, PVC based artificial leather will not require fire retardant treatment for domestic furniture, but may require other fire retardant additives to pass BS5852 Crib 5 or 7 tests, depending upon specific end use.

9. Use a synthetic fire resistant material such as modacrylics with small amounts of additive FRs

Inherent FR fibres based on modacrylics are expensive and could restrict consumer choice. However, some modacrylics contain small amounts of the additive FR antimony trioxide (ATO) to enhance their fire retardancy. ATO has a risk phrase (R40) related to potential inhalation hazards but if it is incorporated and physically well bound in the material the risks can be significantly reduced.

10. Use natural and synthetic blends to reduce cost and increase choice

Blends of different fibres can also be used, e.g. wool/modacylic, wool/nylon blends, wool/FR viscose, etc. Blends of wool with other high performance fibres like Nomex, Kevlar, Basofil, Polybenzimidazole, etc., can also be used, though the latter are very expensive.

Fire-blockers and Interliners

11. Use natural or synthetic flame resistant material or a mixture of both for fire blockers and interliners

Interliners made from inherently fire retardants fibres can further reduce the flammability of the product both for domestic and non-domestic applications. In general if the covering material is made of > 75% natural fibres such as wool or an appropriate wool containing fibre mix, it does not need to be flame retarded to pass the Crib 5 test of BS5852: Part 2:1989. These barrier materials can be multi-layered which allows a product to maintain its fire resistance even if one layer is compromised.

12. Adopt transport sector fire-blocker designs in the domestic market

Fire-blockers, made from inherently fire retardant fibres like oxidized acrylics and aramids, can make the product fire retardant. However, these materials are very expensive. Fire-blockers from oxidised acrylics and aramids are commonly used for aircraft seats; their use is increasing in trains, buses and coaches. So the adoption of design practice in the transport sector could create benefits in the furniture product sector.

The barrier materials can also be a blend of inexpensive natural fibres and expensive synthetic fibres, such as Basofil, Polybenzimidazole, Kevlar, Nomex, etc. Cost may be prohibitive for general consumer markets.

13. Use fibreglass wrapped in an inherently flame retarded fibre to reduce cost

A cheaper alternative is to use glass fibre wrapped in fabric of inherently fire retardant fibres (e.g. FR viscose) or plastic film made from neoprene, PVC which produces fire retardant species when exposed to thermal degradation conditions and to fire.

Covering fabrics

Back-coatings:

14. Consider phasing out the use of classes of brominated FRs in backcoatings that are known to be hazardous.

The environmental performance of a number of classes of brominated fire retardants (Br-FRs) and ATO in traditional back-coatings, such as decaBDE and HBCD, is poor and do not satisfy Ecolabel requirements.

15. Investigate phosphorus-based FRs as an alternative to Br-FRs in backcoatings.

The use of volatile and possible vapour phase-active phosphorus-based FRs should be further explored and effective substitutes found. The only drawback is that these coatings will be fibre specific and so cannot be used for all fibre types and blends.

16. Investigate alternative synergists to, and phase out the use of, ATO.

ATO, the most common synergist for Br-FRs, also has environmental issues related to its inhalation toxicity, although these can be managed by effective matrix incorporation to reduce inhalation exposure. This compound could be replaced by other synergists such as the zinc stannates.

Stannates show synergism with halogenated compounds in some chemical finishes and when used as additive fire retardants in polymers. However, zinc hydroxystannate and zinc stannate are more expensive than ATO and so have not been used in commercial formulations. Consequently, the assessment of material and product fire performance using these alternative synergists has not yet been done.

17. Investigate the use halogen-free back-coatings and other emerging technologies

There are some halogen-free back-coating formulations available, such as MelaphosFR™ Dartex. However, it is not clear to which fibre types these will be applicable. Thor has also developed alumina trihydrate (ATH) and exfoliating graphite containing coatings, which work by providing physical fire barrier protection, but these may need to be supplemented by chemical FR technologies that are effective in the gas phase.

Additive flame retardants:

Use polymeric additives in synthetic fibre materials

If additive fire retardants are to be used in synthetic fibres, there is advantage in them being polymeric in nature – this would increase their likelihood of satisfying REACH.

Chemical finishes:

Investigate water-based finishes with surface modification by plasma technology

For cotton and cotton/polyester blends, durable chemical finishes such as Pyrovatex (Huntsman, formerly Ciba) or Proban (Rhodia) are usually applied. The conventional water-based finishes could be replaced by surface modification by plasma technology. The interest in this has increased with the recent development of atmospheric plasma machines for processing wide widths of fabrics although no current fire retardant successful example exists at the present time.

Foam and Other Fillings

18. Investigate the use of graphite impregnated foam in the domestic market

Physical fire protection of foam seating by the introduction of graphite impregnated foam (GIF) as an inherently fire-resistant foam is widely used in aircraft and other mass transport systems. GIF-foams may be recommended as the best environmental performing technology but concerns exist on potential cost implications. They also have a need for additional chemical FRs to assist gas phase retardancy.

19. Investigate replacing halogenated phosphorus FRs with non-halogenated phosphorus FRs

In regard to chemical FR technologies, the halogenated phosphorus based FR chemicals currently used for fire retarding foams could be replaced by non-halogenated phosphorus based fire retardant, such as triarylphosphate, organic phosphate ester with triphenyl phosphate. Whichever alternative chemical FRs are considered, their hazard and risk assessment and CLP status would need to be reviewed.

However, it is noted these are additive FRs and are not reactive. While some may be able to satisfy the Ecolabel risk phrase criteria they would be excluded because of not being reactive. So the "additive" constraint is unacceptable as no conventional polyurethane foams could satisfy this requirement. Also, in regard to GPP, a move to non-chlorinated FRs would increase costs and in some cases substantially so.

20. Review and continue to develop nanocomposite foams as an alternative to conventional polyurethane foams

There has been a considerable amount of research in developing polymer nanocomposite foams, but current findings suggests they still need other fire retardant to adequately pass fire performance tests. However, most of the effort to date has been at a laboratory scale and are not yet commercially available. So while this can rightly be seen as an emerging technology it is unlikely to provide the required degree of fire retardancy on its own without the aid of other FRs. The benefit is the potential reduction in the amount of chemical FR used. Review and continue to develop nanocomposite foams as an alternative to conventional polyurethane.

21. Most FR foams for interior furnishings rely currently on additive chemical and physical FR technologies, including those that would satisfy R-phrase criteria. The "additive" FR criteria should not apply to foams unless viable alternatives are available.

Interior Furnishings

22. Use inherent fire retardant materials where possible

Inherent FR approaches are possible for many textiles, for example the use of modified acrylic/cotton blends (i.e. a partially inherently FR blend) was used in the USA, albeit with different regulatory requirements. There is also some use of inherently FR polyester and wool or wool blends in coverings. These provide opportunities to use inherent FR materials options but they may be seen as limited within the current vast range of materials and constructions currently available.

23. Allow use of synthetic, inherently fire retardant interliners

Technically, interliners may be used as a design alternative to eliminate chemical FR use. Consultation with users revealed a view that they may be of limited use in gaining environmental improvement since it is believed that most interliners in the UK were of cotton, which would require treatment with FRs. Inherent FR materials such as aramid would be possible, but would cost approximately ten times more. So while technical alternatives do exist and can be recommended as are good environmental performers (in risk phrase terms), their costs and market constraints may be prohibitive at this point in time.

24. Encourage use of treated top cover and treated foam as a means of phasing out Br-FRs

A general approach to meet flammability requirements by using a treated top cover (Pyrovatex or equivalent) and by treated foam works well technically and was seen by consultees as workable. One environmentally friendly approach is the use of ammonium polyphosphate (APP) based product that can only be a soak durable treatment, but can meet up to a crib 5 standard over flammable foam. Brominated FRs in backcoated textiles have some advantages due to their flexibility in application. However, the use of poor environmentally performing brominated FRs should not continue. There appears to be market acceptance that brominated FRs will be excluded.

25. Encourage a switch from halogenated phosphorus FRs to non-halogenated equivalents

In regard to foam fillings, it is possible to replace chlorinated phosphorous based FRs with non-chlorinated ones and there was a general consensus from consultees that non-chlorinated FR compounds were starting to become commercially available for foams. These are for example being introduced into office furniture by one foam manufacturer, with an eventual ambition of introduction into interior furnishings in households.

This switch could be encouraged by building experience of the fire performance of non-chlorinated FR products and introducing ecolabel criteria to encourage adoption when it is known that fire safety can be assured.

26. Modify Ecolabel requirements that specifically excluded additive and/or chlorinated FRs to enable the use of adequately classified non-chlorinated phosphorus chemical FR technologies

For those non-chlorinated phosphorus chemical FR technologies which have an adequate classification to satisfy the Ecolabel risk phrase criteria, these should be recommended as best environmental performers, particularly given the potential difficulties of the costs and market acceptance of GIF-foams. However, these FRs would not currently satisfy the Ecolabel requirement that excludes additive chemical FRs. This requirement should be reviewed.

Mattresses

27. Encourage better design and use of inherent FR materials to obviate the need for FRs

In the consultation, one example was found of a mattress manufacturer who has met the UK legislative requirements on fire performance using a combination of materials (wool) and changes in design (side seaming rather than tape edging) with no use of chemical FRs. Many of the materials in conventional mattresses are polyester and polypropylene, and the flammability requirements can be met with non-halogenated compounds.

28. Encourage a switch from halogenated phosphorus FRs to non-halogenated equivalents while recognising the needs of polyurethane foams

Polyurethane foam mattresses currently require chlorinated or non-chlorinated phosphorus FRs (see discussion in Section 4.1.3). The chlorinated compounds are regarded as the standard FR chemicals, with non-chlorinated being less characterised with respect to environmental perform.

Electronic Products

29. Use inherently FR materials for casings and enclosures

While this is recommended because the use of inherent FR materials in casings and enclosures is possible, the costs may be prohibitive for the high performance polymers and composites that could be used. Other life cycle factors such as weight and total energy use in manufacture may also limit the use of metals.

30. Phase out decaBDE/ ATO FRs in favour of phosphorus-based FRs for casings and enclosures

The unacceptability of decaBDE on chemical hazard and risk phrase grounds, the exclusion of most PBDEs in ecolabels, and the concerns expressed about ATO, indicate that while this is one of the best fire performing FR technologies it is one of poorest environmental performers. Other additive chemical FR technologies based on phosphorus based FRs which satisfy current risk phrase criteria are the best performing but care is required to ensure that only those FRs that are chemically classified and shown to be satisfactory should be included. This may be achieved with an appropriate phase out strategy.

31. Allow brominated FRs in applications where they are chemically bound to the substrate, for instance reactive TBBPA in printed circuit boards

For printed circuit boards the reactive and brominated FR TBBPA satisfies the risk phrase criteria as a monomer but it should be excluded if its residual unreacted concentration in a product fails to satisfy ecolabel criteria. The existence of inherent FR materials in high specification PCBs offers the best environmental performance but the cost of adopting this current technology in consumer electronic products would be prohibitive.

32. Review and restrict the use of exclusions to avoid exclusion of potentially useful chemical FRs in low hazard situations

While the exclusion of some brominated FRs is justified on environmental grounds, such exclusions should not be applied to all halogenated FRs that could be used in electronic product applications.

A number of chlorophosphorus based FRs with good low hazard environmental performance are available and could replace brominated FRs so these should not be arbitrarily excluded. Similarly, the same arbitrary position on excluding all brominated FRs could exclude many of the new polymeric brominated FRs in spite of their potential low hazard status within REACH and CLP.

33. Ensure that alternative chemical FRs to halogenated FRs are hazard assessed and their classification harmonised, and risk assessed if required, to give potential users confidence in adopting alternatives that are known to be less hazardous than the FRs they replace.

One consultee commented that they had invested in replacement FRs only to find that these too failed to satisfy ecolabel requirements.

34. Consider the use of a white list of acceptable FR chemicals

Technically, a white list approach is attractive as it presents manufacturers with a definite, albeit limited, choice of acceptable FR technologies. This would also simplify the recycling of these materials in the future. Some survey respondents in the electronics sector were in favour of a white list approach, which contrasted with the views expressed from the textiles sector. One of the problems foreseen was the criteria for inclusion and the large amount of activity that would be generated from various plastics and FR manufacturers that might make this process difficult to manage.

General Recommendations

35. There is significant scope to move towards design-based and inherent FR approaches which can avoid the use of chemical FR technologies. However, adoption of these better environmentally performing technologies, as measured by risk phrases and the use of exclusion criteria, may not in all cases offer the best whole life environmental performance at reasonable cost, and this may exclude chemical FR technologies that are good environmental performers.

36. While adoption of inherent FR technologies is to be encouraged, it may take some time for this to occur and it may be constrained by costs and other technical, environmental and market factors. It is therefore prudent to maintain Ecolabel approval of safe and low hazard chemical FR technologies that can play a role in maintaining product fire retardancy standards. This may require that existing Ecolabel criteria be reviewed and modified to enable a balanced position to be achieved which does not compromise human or environmental safety or compromise advances in fire safety that have been achieved with existing technologies.

37. Exclusion of brominated FRs is technically possible for all product groups. Such exclusion is required for those classes of brominated FR that produce unacceptable hazards and the application of the precautionary principle is justified.

38. Exclusion of chlorinated FRs is also possible for almost all product groups, although their possible substitutes in foam are not as well characterised with respect to risk and performance.

39. The descriptions of terms such as “reactive”, “inherent FR” or “additive” was criticised by certain respondents as sometimes misleading, and unable to describe accurately the way in which some FR chemicals are incorporated or act. Similarly, exclusion based on such terms is artificial and non scientific in risk assessment terms and the elimination or modification of such vocabulary would be helpful.

40. Ecolabel criteria should be closely allied to the process of REACH in Europe and benefit from the hazard and risk data gathering exercises that from part of REACH for all chemical FR technologies

41. There was general support for inclusion of a flammability criterion in the EU Ecolabel.

Are the Current EU Ecolabel Criteria Fit For Purpose?

The existing EU Ecolabel criteria for the products considered here are too restrictive and are not consistently based on the risk phrase approach to environmental performance. Meaningful and balanced Ecolabel criteria are likely to be based on:

1. Encouragement to use non-chemical FR technologies such as product design and inherent FR materials. For GPP this would also require it being achieved at reasonable cost.

2. Exclusion of any chemical FRs that are known to be hazardous through appropriate risk-phrase hazard assessment and, where appropriate, risk assessment. It is not appropriate to exclude all classes of brominated FRs due to the poor environmental performance of some classes.

3. Inclusion of chlorinated FRs that meet ecolabel hazard criteria.

4. Inclusion of both additive and reactive chemical FR types, as currently defined, but subject to other ecolabel hazard criteria. It is proposed that the use of exclusion criteria based on “reactive” and “additive” terminology cease, and the use of such terminology in the setting of criteria should be avoided.

5. Alignment of criteria setting with REACH and CLP in Europe; this should include consideration of the effect of FRs being chemically and physically bound into materials rather than based on free molecule hazard assessments.

6. Regular review of the criteria to keep pace with hazard and risk information developments under REACH and CLP. FR chemicals should not be used in ecolabel products unless they have adequate toxicity data to ensure that no classification is required in respect of the specific risk phrases listed in the ecolabel. Absence of data and absence of classification should not mean that an FR is acceptable.

7. A fire retardancy criterion to ensure the fire performance of products is not compromised.

4 Methods and approach

This final report is constructed from four technical reports that each have their own methodologies. These are available as Annexes to the Technical Report and include:

1: Legislative Landscape
2: Risk Assessment
3: FR Technology Survey
4: Ecolabel Market Survey

The context for the recommendations is the existing Ecolabel scheme criteria within the framework for FR technology environmental performance assessment presented in Annex 4.

In brief, a comparison of various Ecolabel schemes in Europe provides criteria for the environmental assessment of products containing FRs – these generally contain:

- A risk phrase approach to chemical safety – this is based on the precautionary principle applied to risk phrases drawn from current chemical hazard based classification in Europe, not formal European risk assessment findings.

- The use of exclusions and exemptions – sometimes of whole classes of compounds, such as organohalogens, often combined with specific exemptions of particular compounds.

- In some cases, the exclusion of “additive” FRs and the retention of “reactive” FRs for mattresses and textiles.

It is noted that no attempt was made in this work to consider environmental performance in terms of life cycle environmental impact assessment with a consideration of for example energy and water use, waste production and environmental emissions across the whole life cycle from component manufacture to end of product life. Formal life cycle assessment (LCA) is possible but is beyond the scope of the current project.

The context for the recommendations made here is the existing Ecolabel scheme criteria and a framework for FR technology environmental performance assessment. A hierarchical approach to fire retardancy is used for this assessment which excludes LCA concerns, whose analysis across the range of chemicals and product groups studied is too complex for this current study to incorporate.

This approach is based on the premise that the avoidance of FR chemicals is to be preferred through either the use of alternative intrinsically fire retardant materials or through product design to achieve the fire retardancy required. This is consistent with the use of green chemistry principles and the precautionary principle applied to an assessment of potential human and environmental exposure hazards associated with FR chemicals. The most general approach would therefore seek to minimise human exposure and environmental impact.

The FR technology hierarchy adopted is assumed in each case to achieve the required product fire retardancy in order to at least maintain, and potentially to improve fire safety standards; in order of priority the hierarchy is:

  - Use of inherently fire retardant materials
  - Design of products
  - Use of chemical fire retardants

5 Limitations of the Study

The study was limited by the extent of the FR Technology Survey and the Ecolabels Awareness consultation. The former involved only 57 individual organisations out of 400 who were invited. Despite this, there were representative responses across all of the product sectors and FR manufacturers with the exception of the manufacturer of particular textile treatments in Europe. A larger statistical sample would have enabled greater cross correlation of the findings.

The EU Ecolabel consultation only involved 12 organisations but these were spread across all of the products of relevance. The views recorded are therefore from a small cohort and may be biased by the particular experience of the individuals consulted. Despite this the views expressed aligned very well with the findings of the FR Technology survey.

Significant effort was put into the collection of information on FR risk assessment and the authors acknowledge the expert support of the Environment Agency in obtaining key information sources and for their critical review of drafts of each version of the working document report – there were 3 in total. Both the risk assessment study and the review of the legislative landscape involved the compilation of complex histories of development and while many of the nuances of change over time were obtained it is not certain that all of the important ones have been identified and communicated. It is also unlikely that not all of the product safety regulation across the EU has been obtained; this is particularly difficult to trace for the newer member states.

In common with all chemicals, the paucity of FR risk assessment data globally and the lack of complete and in some cases consistent chemical classification data, has frustrated the more critical assessment of EU Ecolabel criteria setting in regard to alternative FR technologies. This however, raises doubts about the ability of Ecolabel bodies to reliably set and apply their criteria. The information flows to support REACH and CLP will assist this in the future.

Appendix A: Summary Tables of FR Chemical Risk Assessment and Classification

Table 1: Chemical FRs Subject to European Risk Assessment

Name	CAS number	EU Number	Abbreviation	Latest Assessment	Risk Phrases[#]	Hazard Class and Category Code(s)[##]	Hazard Statement Code(s)[##]	Workers	Consumers	Man via Environment	Aquatic	Terrestrial	Atmosphere	Secondary poisoning	STP	Comments
PENTABROMODIPHENYL ETHER	32534-81-9	251-084-2	Penta BDE	2000	Xn; R48/21/22 R64 N; R50-53	Acute Tox. 4 Acute Tox. 4 Aquatic Acute 1 Aquatic Chronic 1	H312 H302 H400 H410"	(i) (iii)	(i) (iii)	(i) (iii)	(iii)	(iii)	(ii)	(iii)	(i)	Banned. Possible risk to babies through human breast milk. Possible secondary poisoning.
OCTABROMODIPHENYL ETHER	32536-52-0	251-087-9	Octa BDE	2003	Repr. Cat. 2; R61 Repr. Cat. 3; R62	Acute Tox. 4 Aquatic Acute 1 Aquatic Chronic 1	H302 H400 H410"	(i) (iii)	(ii)	(i)	(ii)	(i)	(ii)	(i)	(i)	Banned. Respiratory and female fertility effects. Possible risk of secondary poisoning and more toxic degradation products
BIS(PENTABROMODI PHENYL) ETHER	1163-19-5	214-604-9	Deca BDE	2003 2004 2007	N; R50-53	N/C		(i)	(i)	(i)	(ii)	(ii)	(ii)	(i)	(ii)	Possible risk of secondary poisoning and more toxic

Name	CAS number	EU Number	Abbreviation	Latest Assessment	Risk Phrases#	Hazard Class and Category Code(s)##	Hazard Statement Code(s)##	Workers	Consumers	Man via Environment	Aquatic	Terrestrial	Atmosphere	Secondary poisoning	STP	Comments
																degradation products
TETRABROMOBIS PHENOL-A	79-94-7	201-236-9	TBBP-A or TBBPA	2006	N; R50-53	N/C		(ii)	(ii)	(ii)	(i) (iii)	(i) (iii)	(i)	(ii)	(ii)	Very toxic to aquatic organism
HEXABROMOCYCLO DODECANE	25637-99-4	247-148-4	HBCDD or HBCD	2008	N; R50-53 R62/63, R64 proposed	N/C		(i) (iii)	(ii)	(ii)	(iii)	(iii)	(ii)	(iii)	(iii)	Possible neuro-toxicity
DIANTIMONY TRIOXIDE	1309-64-4	215-175-0	ATO	2008	R40 R38 proposed by rejected	Carc.2	H351	(iii)	(ii)	(ii)	(iii)	(ii)	(ii)	(ii)	(ii)	Possible skin irritation
TRIS(2-CHLORO-1-METHYLETHYL) PHOSPHATE	13674-84-5	237-158-7	TCPP	2008	R22 proposed	N/C		(iii)	(ii)	(ii)	(ii)	(ii)	(ii)	(ii)	(ii)	Possible fertility and developmental toxicity
TRIS[2-CHLORO-1-(CHLOROMETHYL)ETHYL] PHOSPHATE	13674-87-8	237-159-2	TDCP	2008	N; R51-53 R22 proposed	N/C		(i) (ii)	(i) (ii)	(iii)	(iii)	(iii)	(iii)	(iii)	(iii)	Possible female fertility effects
2,2-BIS(CHLOROMETHYL) TRIMETHYLENE BIS[BIS(2-CHLOROETHYL) PHOSPHATE]	38051-10-4	253-760-2	V6	2008	Possible R60 due to impurity	N/C		(ii)	(ii)	(ii)	(ii)	(ii)	(ii)	(ii)	(ii)	No risks identified
TRIS(2-CHLOROETHYL) PHOSPHATE	115-96-8	204-118-5	TCEP	2009	Carc. Cat. 3; R40 Repr. Cat. 2; R60	Carc. 2 Repr. 1B Acute Tox. 4 Aquatic Chronic	H351 H360 F H302	(iii)	(iii)	(ii)	(ii)	(ii)	(ii)	(ii)	(ii)	Possible carcinogenicity unless contaminated

Name	CAS number	EU Number	Abbreviation	Latest Assessment	Risk Phrases#	Hazard Class and Category Code(s)##	Hazard Statement Code(s)##	Workers	Consumers	Man via Environment	Aquatic	Terrestrial	Atmosphere	Secondary poisoning	STP	Comments
					Xn; R22 N; R51-53	2	H411									
Medium chain chlorinated paraffins	85535-85-9	287-477-0	MCCP	2007	R64 R66 N; R50-53	Lact. Aquatic Acute 1 Aquatic Chronic 1	H362 H400 H410	(iii)	(ii)	(ii)	(iii)	(iii)	(ii)	(iii)	(ii)	
Short chain chlorinated paraffins	85535-84-8	287-476-5	SCCP	2008	Carc. Cat. 3; R40, R66 N; R50-53	Carc. 2 Aquatic Acute 1 Aquatic Chronic 1	H351 H400 H410	(ii)	(ii)	(ii)	(i) (iii)	(i)	(ii)	(iii)	(ii)	

Risk phrases from Table 3.2 of CLP Annex VI ## Hazard phrases from Table 3.1 of CLP Annex VI N/C Not classified on Annex VI of CLP

EU Risk Assessment standard "conclusions" statements:

(i) There is a need for further information and/or testing

(ii) There is at present no need for further information and/or testing and no need for risk reduction measures beyond those which are being applied already.

(iii) There is a need for limiting the risks; risk reduction measures which are already being applied shall be taken into account

It should be noted that the risk assessments strictly only apply to a particular physical form of a chemical and in a particular application or use for which it was assessed. It cannot therefore be automatically assumed that a chemical assigned conclusion (ii) is necessarily safe in all its forms or uses.

It should also be noted that, we believe that, the ESIS data are no longer kept up-to-date although there is no statement to that effect on their website. Annexe VI CLP contains more up-to-date data for some chemicals, but is currently far from complete for others.

Table 2: Chemical Classification of Some Commercial Flame Retardants Chemicals from the FR Technology Survey reported in Annexe 3.

Chemical Name from Survey	Formal Name	CAS NO	ESIS Risk Assessment	Hazard Classification from EA ACCESS Database	ESIS Classification	chemBlink[18] R phrases	chemBlink S Phrases
2,2-bis(chloromethyl)trimethylene bis(bis(2-chloroethyl)phosphate) (V6)		38051-10-4	Y		N/C	N/A	
2,4,6 Tribromophenol[19]		118-79-6	N		N/C	R20/22, R36/37/38, R51/53	S26, S36/37, S61
ammonium polyphosphate		68333-79-9	N/A		N/A	N/A	
Bisphenol A Bis-(Diphenyl Phosphate)		181028-79-5	N/A		N/A	N/A	
bis(Tribromophenoxy)ethane	1,1'-[ethane-1,2-diylbisoxy]bis[2,4,6-tribromobenzene]	37853-59-1	N		N/C	R20/22; R36/37/38; R51/53	S26; S37/39; S61
cresyl Diphenyl Phosphate	diphenyl tolyl phosphate	26444-49-5	N		N/C	N/A	
Decabromodiphenyl-oxide?? (DecaBDE) CAS NO refers to decabromodiphenyl ether	bis(pentabromophenyl) ether	1163-19-5	Y		N/C	R20/21/22	S36/37
Decabromodiphenylethane	1,1'-(ethane-1,2-	84852-	N		N/C	N/A	

18 http://www.chemblink.com/
19 https://www.who.int/ipcs/publications/cicad/cicad_66_web_version.pdf

Chemical Name from Survey	Formal Name	CAS NO	ESIS Risk Assessment	Hazard Classification from EA ACCESS Database	ESIS Classification	chemBlink[18] R phrases	chemBlink S Phrases
	diyl)bis[pentabromobenzene]	53-9					
diethylphosphinic acid, aluminium salt		N/A	N/A		N/A	N/A	
Ethane-1,2-bis(pentabromophenyl)	1,1'-(ethane-1,2-diyl)bis[pentabromobenzene	84852-53-9	N		N/C	N/A	
Hexabromo-cyclododecane		25637-99-4	Y		N/C	N/A	
Melamine	1,3,5-Triazine-2,4,6-triamine	108-78-1	N		N/C	R20/21; R44	S36/37
Melamine Cyanurates	1,3,5-triazinane-2,4,6-trione	504-19-8	N/A		N/A	N/A	
Melamine polyphosphate		20208-95-1	N/A		N/A	N/A	
phosphorus polyols		N/A	N/A		N/A	N/A	
Poly(dibromostyrene)		148993-99-1	N/A		N/A	N/A	
Resorcinol Bis-(diphenyl Phosphate)	tetraphenyl m-phenylene bis(phosphate)	57583-54-7	N		N/C	N/A	
Tetrabromobenzoate ester		N/A	N/A		N/A	N/A	
Tetrabromo-bisphenol-A	2,2',6,6'-tetrabromo-4,4'-isopropylidenediphenol	79-94-7	Y	? R 50/53	N; R50-53 S60, S61	R36/37/38	S26;S37/39
Tetrabromophthalic anhydride	4,5,6,7-tetrabromo-2-benzofuran-1,3-dione	72625-95-7	N/A		N/A	N/A	
Tetrabromobenzoate ester		N/A	N/A		N/A	N/A	
Tetrabromophthalate ester	bis(2-ethylhexyl) tetrabromophthalate	26040-51-7	N		N/C	N/A	
Triarylphosphates isopropylated	Phenol, isopropylated, phosphate (3:1)	68937-41-7	N	N: R51/53	N/C	N/A	
Triarylphosphates	tris(isopropylphenyl)	26967-	N		N/C	N/A	

Chemical Name from Survey	Formal Name	CAS NO	ESIS Risk Assessment	Hazard Classification from EA ACCESS Database	ESIS Classification	chemBlink[18] R phrases	chemBlink S Phrases
isopropylated 7% phosphorus	phosphate	76-0					
Tribromophenyl allyl ether	2-(allyloxy)-1,3,5-tribromobenzene	3278-89-5	N		N/C	N/A	
Tricresyl Phosphate	tris(methylphenyl) phosphate	1330-78-5	N		N/C	R39/23/24/25; R51/53	S20/21; S28A; S45; S61
Tris (2,3-dichloroisopropyl) phosphate	tris[2-chloro-1-(chloromethyl)ethyl] phosphate	13674-87-8	Y		N/C	N/A	
Tris (2-monochloropropyl) phosphate	tris(2-chloro-1-methylethyl) phosphate	13674-84-5	Y		N/C	N/A	
Trxylyl phosphate		68952-33-0	N		N/C	N/A	

N/A – Not available
N/C – Not Classified in the Annex I of Directive 67/548/EEC

Appendix B: Chemical FRs Subject to European Hazard and Risk Assessment and their EU Ecolabel Status

Note: red text signifies FRs that satisfy Ecolabel requirements.

Name	CAS number	EU Number	Abbreviation	Latest Assessment	Risk Phrases#	Comments	Acceptability in EU Ecolabel		
							Mattresses and Textiles	Televisions	PCs and Laptops
PENTABROMO-DIPHENYL ETHER	32534-81-9	251-084-2	Penta BDE	2000	Xn; R48/21/22 R64 N; R50-53	Banned. Possible risk to babies through human breast milk. Possible secondary poisoning.	Excluded on basis of risk phrases R50-53 and as an additive FR	Excluded as a polybrominated diphenyl ether (PBDE)	Excluded as a PBDE
OCTABROMO-DIPHENYL ETHER	32536-52-0	251-087-9	Octa BDE	2003	Repr. Cat. 2; R61 Repr. Cat. 3; R62	Banned. Respiratory and female fertility effects. Possible risk of secondary poisoning and more toxic degradation products	Excluded on basis of risk phrases R61, R62 and as an additive FR	Excluded as a PBDE	Excluded as a PBDE
BIS (PENTABROMO-DI PHENYL) ETHER	1163-19-5	214-604-9	Deca BDE	2003 2004 2007	N; R50-53	Possible risk of secondary poisoning and more toxic degradation products	Excluded on basis of risk phrases and as an additive FR	Originally excluded as a PBDE, then included by amendment to Directive 2002/95/EC, this being annulled by ECJ. Hence excluded	Originally excluded as a PBDE, then included by amendment to Directive 2002/95/EC, this being annulled by ECJ. Hence excluded

Name	CAS number	EU Number	Abbreviation	Latest Assessment	Risk Phrases#	Comments	Acceptability in EU Ecolabel		
							Mattresses and Textiles	Televisions	PCs and Laptops
TETRABROMO-BIS PHENOL-A	79-94-7	201-236-9	TBBPA or TBBA	2006	N; R50-53	Very toxic to aquatic organism	Acceptable as a reactive FR provided that residual unreacted FR is less than 0.1% and provided that the reacted compound is no longer classified with excluded risk phrases	Acceptable as a reactive FR provided that residual unreacted FR is less than 0.1% and provided that the reacted compound is no longer classified with excluded risk phrases	Acceptable as a reactive FR provided that residual unreacted FR is less than 0.1% and provided that the reacted compound is no longer classified with excluded risk phrases
HEXABROMO-CYCLO DODECANE	25637-99-4	247-148-4	HBCDD or HBCD	2008	N; R50-53 R62/63, R64 proposed	Possible neuro-toxicity	Excluded on basis of risk phrases R50-53, R62/63	Excluded on basis of risk phrases R50-53, R62/63	Excluded on basis of risk phrases R50-53
DIANTIMONY TRIOXIDE	1309-64-4	215-175-0	ATO	2008	R40 R38 proposed by rejected	Possible skin irritation	Excluded as an additive FR	Excluded on basis of risk phrase R40	Excluded since named in Annex 1 of CPL Directive (67/548/EEC)
TRIS (2-CHLORO-1-METHYLETHYL) PHOSPHATE	13674-84-5	237-158-7	TCPP	2008	R22 proposed	Possible fertility and developmental toxicity	Excluded as an additive FR	Acceptable on risk phrases	Acceptable on risk phrases
TRIS [2-CHLORO-1-(CHLOROMETHYL) ETHYL] PHOSPHATE	13674-87-8	237-159-2	TDCP	2008	N; R51-53 R22 proposed	Possible female fertility effects	Excluded as an additive FR and on risk phrase R51-53	Excluded on risk phrase R51-53	Excluded on risk phrase R51-53 for parts >25g

Name	CAS number	EU Number	Abbreviation	Latest Assessment	Risk Phrases#	Comments	Acceptability in EU Ecolabel		
							Mattresses and Textiles	Televisions	PCs and Laptops
2,2-BIS (CHLOROMETHYL) TRIMETHYLENE BIS [BIS (2-CHLOROETHYL) PHOSPHATE]	38051-10-4	253-760-2	V6	2008	Possible R60 due to impurity	No risks identified	Excluded as an additive FR and as R60 if present	Excluded on risk phrase R60 if present	Excluded on risk phrase R60 if present
TRIS (2-CHLOROETHYL) PHOSPHATE	115-96-8	204-118-5	TCEP	2009	Carc. Cat. 3; R40 Repr. Cat. 2; R60 Xn; R22 N; R51-53	Possible carcinogenicity unless contaminated	Excluded as an additive FR and on risk phrases R40, R60, R51-53	Excluded on risk phrases R40, R60, R51-53	Excluded on risk phrases R60, R51-53 for parts >25g
Medium chain chlorinated paraffins	85535-85-9	287-477-0	MCCP	2007	R64 R66 N; R50-53		Excluded as an additive FR and on risk phrase R50-53	Excluded on risk phrase R50-53	Excluded specifically by CAS number
Short chain chlorinated paraffins	85535-84-8	287-476-5	SCCP	2008	Carc. Cat. 3; R40, R66 N; R50-53		Excluded as an additive FR and on risk phrase R50-53	Excluded on risk phrase R50-53	Excluded specifically by CAS number

Risk phrases from Table 3.2 of CLP Annex VI   Hazard phrases from Table 3.1 of CLP Annex VI

Appendix C: Chemical FRs Not Subject to European Risk Assessment and Their EU Ecolabel Status

Note: red text signifies FRs that satisfy Ecolabel risk phrase requirements and blue text those FRs which are excluded on the basis of being an "additive" FR.

Chemical Name from Survey (*formal name in italics*)	**CAS number**	**EC Number**	**Classification**	**Acceptability in EU Ecolabel**		
				Mattresses and Textiles	Televisions	PCs and Laptops
2,4,6 Tribromophenol[20]	118-79-6	204-278-6	R22, R36/38 X, N; R20/21/22 R36/37/38, R51/53, R20/22, R39/23/24/25, R23/24/25, R11, R63, R43-45 Xi,N,Xn,T,F; R36/37/38, R51/53, R20/22, R39/23/24/25, R23/24/25, R11, R63, R43-45 R20/22, R36/37/38, R51/53	Excluded as additive and on risk phrases R51/53, R63	Excluded on risk phrases R51/53, R63	Excluded on risk phrase R51/53 for plastic parts >25g
ammonium polyphosphate	68333-79-9	269-789-9	"Insufficient data" No significant [health] hazards	Excluded as additive FR	Acceptable on risk phrases	Acceptable on risk phrases
bisphenol A diphosphate	181028-79-5		"None listed"	Excluded as additive FR	Acceptable on risk phrases	Acceptable on risk phrases
bisphenol A bis (diphenyl phosphate)	5945-33-5		R53	Excluded as an additive FR and on risk phase	Excluded on risk phrase R53	Acceptable on risk phrases
bis(Tribromophenoxy)ethane	37853-59-1	253-692-3	R20/22; R36/37/38; R51/53	Excluded as additive FR and	Excluded on risk phrase R51/53	Excluded on risk phrase R51/53 for

20 https://www.who.int/ipcs/publications/cicad/cicad_66_web_version.pdf

Chemical Name from Survey (*formal name in italics*)	CAS number	EC Number	Classification	Acceptability in EU Ecolabel		
				Mattresses and Textiles	Televisions	PCs and Laptops
1,1'-[ethane-1,2-diylbisoxy]bis[2,4,6-tribromobenzene]				on risk phrase R51/53		plastic parts >25g
Cresyl Diphenyl Phosphate ***diphenyl tolyl phosphate***	26444-49-5	247-693-8	N; R36/37/38, R51/53 Xn; R48, cat 2 reprotoxin R60 R 50 / 53	Excluded as additive FR and on risk phrases R50/53, R51/53, R60	Excluded on risk phrases R51/53, R50/53, R60	Excluded on risk phrases R51/53, R50/53, R60 for plastic parts >25g
Decabromodiphenylethane or Ethane-1,2-bis (pentabromophenyl) 1,1'-(ethane-1,2-diyl) bis[pentabromobenzene	84852-53-9	284-366-9	R22	Excluded as additive FR	Acceptable on risk phrases	Acceptable on risk phrases
diethylphosphinic acid, aluminium salt	225789-38-8		R40 No Tested for this endpoint R42 No R43 No Tested for this endpoint R45 No R49 No R50 No Tested for this endpoint R53 No Tested for this endpoint	Excluded as additive FR	Acceptable on risk phrases	Acceptable on risk phrases
Melamine 1,3,5-Triazine-2,4,6-triamine	108-78-1	203-615-4	XI, Xn; R20/21, R43-44 R20/21; R44	Excluded as additive FR	Acceptable on risk phrases	Acceptable on risk phrases
Melamine Cyanurates 1,3,5-triazinane-2,4,6-trione	504-19-8		Xn; R22	Excluded as additive FR	Acceptable on risk phrases	Acceptable on risk phrases
Melamine polyphosphate	20208-95-1	243-601-5		Excluded as additive FR	Acceptable on risk phrases	Acceptable on risk phrases
Phosphorus polyols	N/A		None found	Acceptable as a reactive FR provided that residual unreacted FR is	Acceptable on risk phrases and as a reactive FR	Acceptable on risk phrases and as a reactive FR

Chemical Name from Survey (*formal name in italics*)	CAS number	EC Number	Classification	Acceptability in EU Ecolabel		
				Mattresses and Textiles	Televisions	PCs and Laptops
				less than 0.1% and provided that the reacted compound is not classified with excluded risk phrases		
Poly(dibromostyrene)	148993-99-1		None found	Acceptable as a reactive FR provided that residual unreacted FR is less than 0.1% and provided that the reacted compound is not classified with excluded risk phrases	Acceptable on risk phrases and as a reactive FR	Acceptable on risk phrases and as a reactive FR
Resorcinol Bis-(diphenyl Phosphate) tetraphenyl m-phenylene bis(phosphate)	57583-54-7	260-830-6	None found	Excluded as additive FR	Acceptable on risk phrases	Acceptable on risk phrases
Tetrabromobenzoate ester	N/A		None found	Acceptable as a reactive FR provided that residual unreacted FR is less than 0.1% and provided that the reacted compound is not	Acceptable on risk phrases and as a reactive FR	Acceptable on risk phrases and as a reactive FR

Chemical Name from Survey (*formal name in italics*)	CAS number	EC Number	Classification	Acceptability in EU Ecolabel		
				Mattresses and Textiles	Televisions	PCs and Laptops
				classified with excluded risk phrases		
Tetrabromophthalic anhydride ***4,5,6,7-tetrabromo-2-benzofuran-1,3-dione***	72625-95-7		Xi; R36/37/38	Acceptable as a reactive FR provided that residual unreacted FR is less than 0.1% and provided that the reacted compound is not classified with excluded risk phrases	Acceptable on risk phrases and as a reactive FR	Acceptable on risk phrases and as a reactive FR
Tetrabromophthalate ester ***bis(2-ethylhexyl) tetrabromophthalate***	26040-51-7	247-426-5	None found	Acceptable as a reactive FR provided that residual unreacted FR is less than 0.1% and provided that the reacted compound is not classified with excluded risk phrases	Acceptable on risk phrases and as a reactive FR	Acceptable on risk phrases and as a reactive FR
Triarylphosphates isopropylated ***Phenol, isopropylated, phosphate (3:1)***	68937-41-7	273-066-3	Rep 3; R62,R63.	Excluded as additive FR and on risk phrases	Excluded on risk phrases R62, R63	Excluded on risk phrases R62, R63 for plastic parts >25g
Triarylphosphates	26967-76-0	248-147-1	None found	Excluded as	Acceptable on	Acceptable on

Chemical Name from Survey (*formal name in italics*)	CAS number	EC Number	Classification	Acceptability in EU Ecolabel		
				Mattresses and Textiles	Televisions	PCs and Laptops
isopropylated 7% phosphorus tris(isopropylphenyl) phosphate				additive FR	risk phrases	risk phrases
Tribromophenyl allyl ether 2-(allyloxy)-1,3,5-tribromobenzene	3278-89-5	221-913-2	R10, R25, R27, R38, R41	Excluded as additive FR	Acceptable on risk phrases	Acceptable on risk phrases
Tricresyl Phosphate *tris(methylphenyl) phosphate*	1330-78-5	215-548-8	Xn,N,T; R21/22, R51/53, R39/23/24/25 R51/53, R39/23/24/25 Rep 2 Xn; R48	Excluded as additive FR and on risk phrase R51/53	Excluded on risk phrase R51/53	Excluded on risk phrase R51/53 for plastic parts >25g
Trixylyl phosphate	68952-33-0	273-166-7	N; R51/53 **Rep.2; R60**	Excluded as additive FR and on risk phrase R51/53	Excluded on risk phrase R51/53	Excluded on risk phrase R51/53 for plastic parts >25g

MSDNs without R-phrase classifications tend to be American and not for sale in Europe, or Chinese, or invite the user to enquire through a web form for further information. Our experience has been that it can be difficult to get the company to recognise chemical name or CAS number (they generally require their own product name) and that response times can be in excess of 7 days.