The Director General

Maisons-Alfort, 11 September 2015

OPINION
of the French Agency for Food, Environmental and Occupational Health & Safety

concerning the "request regarding the fire safety of domestic upholstered furniture"

ANSES undertakes independent and pluralistic scientific expert assessments.
ANSES primarily ensures environmental, occupational and food safety as well as assessing the potential health risks they may entail.
It also contributes to the protection of the health and welfare of animals, the protection of plant health and the evaluation of the nutritional characteristics of food.
It provides the competent authorities with all necessary information concerning these risks as well as the requisite expertise and scientific and technical support for drafting legislative and statutory provisions and implementing risk management strategies (Article L.1313-1 of the French Public Health Code).
Its opinions are made public.
This opinion is a translation of the original French version. In the event of any discrepancy or ambiguity the French language text dated 11 September shall prevail.

On 19 May 2011, ANSES received a request from the Directorate General for Competition, Consumer Affairs and Fraud Control (DGCCRF) to carry out an expert appraisal concerning a "request regarding the fire safety of domestic upholstered furniture".

1. BACKGROUND AND PURPOSE OF THE REQUEST

The fire safety of domestic upholstered furniture is a problem that dates back more than 20 years, both in France and within the European Union, where no consensus agreement has been reached to date, partly because of diverging opinions on the potential risks of flame retardants used in upholstered furniture.

This was the rationale behind the request concerning a scientific literature review on the subject of the possible health risks that may be associated with the general use of flame retardants in domestic upholstered furniture. The aim of the request is mainly to:

- Identify the flame retardants commonly used in upholstered furniture for use in the home and carry out a bibliographic review of existing literature on these substances in terms of human and environmental toxicology;

- Issue recommendations aimed at increasing the effectiveness of possible management methods in the area of flammability of domestic upholstered furniture and reducing the risks associated with use of flame retardants;

- Provide an opinion on the benefit of measures to reduce the flammability of domestic upholstered furniture by weighing the risk of fire against the increased potential health risk related to flame retardants.

This request must be considered within the context of data available on household fires. As an example, in 2012, the Directorate General for Civil Defence and Emergency Preparedness (DGSCGC) recorded 81,027 household fires that required an intervention by firefighters. These fires resulted in 459 deaths, 1332 serious injuries, and 13,350 minor injuries.

- About 70% of fires, irrespective of the severity, occur during the day;
- About 70% of fatal fires occur at night;
- Fatalities more often concern men than women and are mainly concentrated in the adult population and the elderly over 65 years of age.

The causes of these household fires are poorly defined and highly variable, and include electrical or gas failures, or lit cigarettes. One of the commonly discussed practices to reduce the number of fires in homes is to use flame retardants to lower the flammability of upholstered furniture, with an obligation to comply with fire resistance tests. This practice would involve generalised use of treatments for upholstered furniture containing flame retardants and poses the problem of possible health and environmental risks related to use of these chemical substances.

These issues are controversial within the scientific community and civil society, particularly since the toxicity of certain flame retardants used in the past has now been proven, specifically brominated flame retardants (BFRs).

2. ORGANISATION OF THE EXPERT APPRAISAL

ANSES delegated this expert appraisal to the Expert Committee (CES) on Assessment of chemical risks of consumer items and products. The collective expert appraisal had two distinct but complementary parts:

1. The first part of the expert appraisal sought to determine the effectiveness of flame retardants used in upholstered furniture to decrease the frequency and severity of household fires. This part was carried out by the Agency's Working Group (WG) on Human and Social Sciences (HSS) between April 2013 and September 2014. Its aim was to document the following:

- Data available in France on victims of fires caused by ignition of domestic upholstered furniture;
- Data concerning the effectiveness of flame retardants in reducing the frequency and severity of fires in countries that have taken measures to systematically treat domestic upholstered furniture;
- Possible reduction in the number of fire victims that could be expected in France should domestic upholstered furniture be treated with flame retardants;
- Alternative measures to treatment of domestic upholstered furniture with flame retardants, and the effectiveness of these measures.

The data and information collected and analysed by the WG-HSS were diverse and came from many different sources. A review of the scientific and associative literature, and of articles published in the national press was carried out to determine the opinions and standpoints of the various stakeholders. The main institutional reports that evaluated the effectiveness of public policies to prevent the risk of fire were also reviewed critically. The assessment carried out by the WG-HSS was enriched by previous knowledge on the subject, specifically from the United States and the United Kingdom. It appeared to be useful to consider the conditions and context in which measures to promote the use of flame retardants were adopted as a means of household fire prevention, along with the rationale and discussions that took place concerning the effectiveness of these measures and their health and safety consequences.

The WG aimed to establish a clear picture of the available knowledge on household fires in France, by collecting and analysing all available information.

In addition, hearings and interviews were held with experts and qualified individuals with the aim of documenting their points of view.

The report on this part of the expert appraisal was published by ANSES in September 2014[1].

2. The second part of the expert appraisal concerned the potential health and environmental effects of flame retardants used in upholstered furniture. It consisted of three parts aimed at documenting:

- The main fire-retardant substances used in the various matrices of upholstered furniture (foams and textile or synthetic coatings), as well as their regulatory status in terms of the European REACH Regulation[2];
- Their concentrations and potential to migrate and diffuse from the various matrices;
- Their possible effects on health and the environment.

In order to identify the substances used, a bibliographic review was carried out from November 2012 to March 2013. It was supplemented by two surveys performed among manufacturers and stakeholders in the upholstered furniture sector in France and in Europe, as well as hearings for some of these players. The surveys were performed with the support of the FCBA Technology Institute[3].

Moreover, a research and development agreement (CRD) was signed by the Agency and the Alès School of Mining (Alès Centre for Mining Materials - C2MA) and the National Laboratory for Metrology and Testing (LNE). This CRD aimed to:

- Check and, where necessary, supplement information and data on the use of fire retardants in upholstered furniture;
- Acquire data on the potential for migration and diffusion of flame retardants from the various matrices, i.e. foams and coatings.

Lastly, available data were collected on each of the flame retardants identified in earlier steps (bibliographic search, survey, hearings, and CRD), with the aim of documenting their effects on human health[4] and/or on the environment.

After these steps, a synopsis of the results obtained was drafted. This synopsis provides ANSES's position concerning the two questions posed in the request:

- Estimated expected decrease in the frequency and severity of fires in homes that may result from mandatory generalisation of fire-retardant treatments for domestic upholstered furniture.
- Potential health and environmental risks related to mandatory generalisation of fire-retardant treatments for domestic upholstered furniture.

3. ANALYSIS AND CONCLUSIONS OF THE CES

The expert appraisal has two separate parts:

[1] ANSES REPORT regarding the assessment of risks related to exposure to flame retardants in upholstered furniture - Part 1: Effectiveness against the risk of fire of flame retardants in upholstered furniture. https://www.anses.fr/fr/content/%C3%A9valuation-des-risques-li%C3%A9s-%C3%A0-l%E2%80%99exposition-aux-retardateurs-de-flamme-dans-les-meubles

[2] REACH: European Regulation No 1907/2006 on Registration, Evaluation, Authorisation and Restriction of Chemicals.

[3] FCBA: French technical centre operating in the sectors of forestry, cellulose, construction wood and furniture.

[4] Specific toxicity effects of FRs released during fires were not studied as part of this expert appraisal.

1. **The first part of the expert appraisal is a study of published data on the expected effectiveness of fire-retardant treatment of upholstered furniture in reducing the frequency and severity of domestic fires.** The results of this first part of the expert appraisal, carried out by the Agency's Working Group on Human and Social Sciences, was validated by the Expert Committee (CES) on Consumer products on 25 September 2014. This report highlighted the lack of data on the causes of domestic fires, both in Europe and in France. On the basis of available data, primarily from the United Kingdom and the United States, the report showed that these data are insufficient to conclude that fire-retardant treatment of upholstered furniture significantly contributes to reducing the frequency and severity of domestic fires. It therefore seems impossible to determine the possible safety benefit of using flame retardants in upholstered furniture. A number of factors, such as smoking, use of battery-powered smoke detectors/alarms, and the characteristics of housing and populations, play a major role in the study of fires and must therefore be taken into account.

2. **The second part of the expert appraisal had three separate purposes:**

2.1. **To identify the flame retardants most commonly used in upholstered furniture, both on the basis of bibliographic data and on surveys of professionals in the furniture sector**. Documentary research and information updates carried out by the C2MA identified a list of 25 "matrix/flame retardant pairs" most commonly used in the various matrices of upholstered furniture. The concept of "matrix/flame retardant pairs" was developed because it became clear that the choice of the substance to use is highly dependent on the material, or matrix, to be treated. In some cases, the fire-retardant treatment can be optimised by adding another flame retardant or another chemical product with no intrinsic effect, called a synergist. A single flame retardant may sometimes be used to treat different matrices, and each matrix can be complex, i.e. contain multiple coatings. This list of matrix/flame retardant pairs is shown in the table annexed to this opinion.

2.2. **To collect data and information on the toxicity and environmental effects of the identified substances.** To this end, the focus was placed on flame retardant risk assessments published by the main organisations and institutions recognised nationally and internationally. To update these data, a review of the scientific literature covering the period between October 2013 and June 2015 was carried out and supplemented using toxicology databases.

This review showed that all the identified substances are recorded under the REACH Regulation, with three exceptions: guanidine phosphate (GPP), melamine phosphate (MP), and bisphenol-A bis (diphenylphosphate) (BAPP). Experimental data published by companies were, as a minimum, those required to prepare registration dossiers, depending on the tonnage band of the substances.

As such:

- **For registered substances between 100 and 1000 tonnes** (zirconium acetate, phosphinic acid, potassium hexafluorozirconate, DMPPA, TBPH, V6, and phosphoric acid), the data concerning human toxicity are generally limited to a study of subacute toxicity (28 days) and/or another subchronic study (90 days), a reprotoxicity study (fertility and development) in one species, as well as *in vitro* genotoxicity tests. These studies may however not be supplied, if adequate justification is given.
- **For registered substances above 1000 tonnes** (IPTPP, DBDPE, DecaBDE, HBCD, THPC, and Sb_2O_3), chronic toxicity studies are generally supplied, along with carcinogenicity studies. There are very few data in humans for these substances. This is why the review of health effects is based on animal data.

- **For substances that have not been registered,** data are either practically non-existent for two of these substances (GPP and MP), or are limited to sparse data provided by a company to the Australian National Industrial Chemicals Notification and Assessment Scheme (NICNAS), and summarised by the US-EPA (2014)[5] (BAPP). These data are extremely limited.

Moreover, for certain flame retardants there are problems concerning characterisation of the substances they contain. For example, IPTPP is made up of a mixture of several isomers whose identity is not always clear. It is therefore difficult to assess the relevance of the tested mixture with regard to the mixture in the product as it is marketed. This is also the case for TCP, which is available as a complex mixture containing several isomers of cresyl-phosphate, of which only three have been identified (NTP, 1994)[6] (ortho, meta, and para isomers), and one of these (ortho-TCP) is known for its neurotoxicity. The exact composition of the marketed product thus depends on the manufacturing and purification processes used and can therefore vary substantially among manufacturers.

Therefore, given the published data, which are sometimes summaries contained in assessment reports, (without considering the quality of the studies which were not analysed in detail), we can note that:

- **Certain flame retardants** have **reproductive toxicity**. This is the case specifically for HBCD, a category 2 reprotoxic substance, but also TBPH, for which reprotoxic effects have been reported in some studies, and TCP which has caused an effect on ovaries after chronic exposure in adult women. According to the US-EPA (2014)[7], IPTPP has high toxic potential on embryonic development and a chemical structure likely to induce neurotoxic effects. A recent study also showed reprotoxic effects of melamine in mice[8].
- TPP is included on the list of substances to assess as part of REACH due to its **potential endocrine disruptor (ED) effect**.
- Certain flame retardants can be considered **potentially carcinogenic** in humans. This is the case specifically with TDCPP and antimony trioxide which are considered category 2 carcinogens according to the CLP Regulation[9]. Moreover, experts from the US-EPA classified DecaBDE as potentially having carcinogenic effects in humans on the basis of all the available data. Concerning V6, the US-EPA considers that the risk is moderate (US-EPA, 2014)[2]. Regarding TCPP, and based on the results of a 13-week animal study, European experts (EU-RAR, 2008)[10] concluded that some of the observed effects could have a cancerous course, following a non-genotoxic mechanism. Lastly, concerning DBDPE, even though there are no carcinogenicity data, because of the structural similarity

[5] US-EPA 2014 (U.S. Environmental Protection Agency). An alternatives assessment for the flame retardant Decabromodiphenyl ether. Final report.

[6] NTP. Technical report series. No. 433. 325 pp.US Department of Health and Human Services, Public Health Service, National Toxicology Program, 1994.

[7] US-EPA 2014 (U.S. Environmental Protection Agency). Flame retardants used in flexible polyurethane foam: an alternatives assessment update.

[8] Yin RH, Wang XZ, Bai WL, *et al.* (**2013**). The reproductive toxicity of melamine in the absence and presence of cyanuric acid in male mice. Res Vet Sci 94(3):618-627.

[9] CLP: European Regulation No. 1272/2008

[10] EU-RAR 2008. European Union. Risk Assessment Report. Tris[2-chloro-1-methyl) phosphate (TCPP)

with DecaBDE, its carcinogenic potential cannot be ruled out. This is also the case for TBPH (US-EPA, 2014)[11]. THPC appears to have a promoter effect on skin tumours.

- Several flame retardants are suspected of having **neurotoxicity**, either after exposure in adulthood or during development. This is the case in particular for DecaBDE, DBDPE (structural analogue of DecaBDE), and TCP.
- Other flame retardants have **the thyroid as the target organ.** For example, an increase in the weight of the thyroid, along with histopathological changes, has been observed in one study on the effects of V6 over two generations. Effects on the thyroid have also been reported in several studies on HBCD.
- **The immune system** can also be the target of some of these substances, such as TCP for example.

In addition to possible human toxicity, the flame retardants identified as part of this study may have **effects on the environment**:

- The chronic and acute ecotoxicity of TDCPP or HBCD for example is high, as is its persistence in various compartments of the environment.
- Certain flame retardants do not readily biodegrade and therefore persist in the environment. Examples include TCPP, DBDPE, BAPP, TCP, IPTPP, and antimony trioxide. Furthermore, TBPH generates metabolites and degradation products that persist in the environment.

In conclusion, for each of the identified substances, available data do not make it possible to rule out potential toxicity on human health or effects on the environment. For some of these fire retardants, data clearly point to toxicity on certain physiological functions. They are the subject of regulatory measures, as part of the REACH Regulation, in order to limit their use.

2.3. **To evaluate the potential for migration and diffusion of flame retardants when they are incorporated into the various matrices that make up upholstered furniture.**

Given the difficulties involved in performing migration and diffusion studies, a selection of only 10 matrix/flame retardant pairs among the 25 in the table attached in the annex were retained to carry out migration and diffusion studies. The selection criteria were as follows:

- Flame retardants that appear to be critical based on the literature in terms of occurrence in indoor air and in dust, and proven or suspected toxicological potential;
- Flame retardants that are products explicitly found in furniture on the European market;
- At least one matrix/flame retardant pair per fire-retardant treatment system;
- Commercial availability of flame retardants and reagents to carry out measurements;

In addition to reconstituted samples in the laboratory, samples of upholstered furniture from commercial suppliers were provided by the Institut FCBA. One of the objectives of these tests was to compare results for migration and diffusion of flame retardants used in sample matrices from commercial outlets with those obtained for samples that were reconstituted in the laboratory. The results of this study showed that:

- The type of polymer/flame retardant pair is significantly correlated with the migration process;

[11] US-EPA 2014 (U.S. Environmental Protection Agency). An alternatives assessment for the flame retardant Decabromodiphenyl ether. Final report.

- The most hydrophilic substances are likely to cause greater migration processes (e.g. TCPP). Nonetheless, it cannot be ruled out that poorly hydrophilic substances may also readily migrate depending on the structure of the treated materials;
- The method of incorporation of the flame retardant does not appear to guarantee complete immobilisation within the matrix. As a result, flame retardants grafted onto the polymer matrix resulted in migration processes, even though this technique supposedly prevents any subsequent release of the compound. The low proportion of flame retardant could correspond to a product residue that did not react during grafting;
- Diffusion into the air of some particularly volatile compounds, such as TCPP, was confirmed.

As a result, and given current knowledge, it is difficult to clearly identify an inert substance both in terms of diffusion and migration, and it is not possible to guarantee the absence of migration and diffusion, regardless of the flame retardant used.

Given the lack of quantitative data for most of the flame retardants studied in terms of toxicity, exposure, and effects on the environment, it was not possible to quantitatively assess the benefit/risk ratio resulting from generalisation of flame retardant treatment of upholstered furniture.

In conclusion, on the basis of the report issued by the Working Group on Human and Social Sciences on the one hand, and this expert appraisal on the other, the CES recommends that use of flame retardants in domestic upholstered furniture should not be generalised and that alternatives to their use should be given priority.

Moreover, the CES recommends:

- **Implementing a "National fire registry"** collecting all the data on the conditions surrounding fire outbreaks and their severity factors. Statistical data extracted from this National fire registry would make it possible to set up suitable prevention measures and put forward an update of flammability tests for upholstered furniture in view of actual circumstances;
- **Opting for methods of household fire prevention that do not present risks for health and the environment.** In particular, the CES recommends reinforcement and generalisation of certain prevention measures, including mandatory installation of battery-powered smoke detectors/alarms, periodic verification of electrical installations in homes and in collective buildings, and increased awareness campaigns for the population;
- **Improving knowledge on the materials used** and particularly on those imported into the European Union;
- **Developing diffusion measurement methods** that are more representative of actual conditions of use of upholstered furniture, taking into account physical changes in materials during their use;
- **Adapting operating protocols for the measurement of diffusion and migration** to take into account aging of treated upholstered furniture, and to identify factors that influence the stability of flame retardants used in matrices and the potential for migration and diffusion;
- **Analysing the life cycle of treated upholstered furniture** in order to avoid the dispersion of flame retardants in the environment and improve the protection of personnel involved in the recycling sector.

4. CONCLUSIONS AND RECOMMENDATIONS OF THE AGENCY

This expert appraisal aimed to:

- Identify flame retardants used and record their effects on health and the environment;
- Collect and analyse data enabling assessment of a possible reduction in the risk of fire that may be associated with use of flame retardants;

- Establish correlations between data available on the potential health and environmental effects of flame retardants and the reduced risk of fire possibly associated with their use in upholstered furniture for domestic use.

The French Agency for Food, Environmental and Occupational Health & Safety adopts and endorses the conclusions and recommendations of the CES on Assessment of chemical risks of consumer items and products, providing additional conclusions.

The Agency emphasises that assessment of the chemical risks for health and the environment related to flame retardants used in upholstered furniture is characterised by a number of uncertainties because of the lack of available data. The first source of uncertainty is related to the lack of precise data on substances used in the various matrices (foams and coatings) in upholstered furniture, their concentrations, and their potential for migration and diffusion. In sum, the available data proved to be insufficient and of inconsistent quality. A total of 22 substances were identified as the most commonly used flame retardants in upholstered furniture, bearing in mind that there is high, frequent turnover of substances used by manufacturers.

The effects of these 22 substances on health and the environment, particularly long term and at low doses, have been documented in an inconsistent manner on the basis of experimental data obtained in animal models. As such, several substances have one or more effects, including:

- In humans: proven or suspected reprotoxicity, a potential effect as endocrine disruptors, carcinogenicity, neurotoxicity, an effect on the thyroid, and on the immune system;
- In the environment: ecotoxicity, persistence, or bioaccumulation.

Of the 22 substances, 19 have been registered as part of the REACH Regulation, and 3 have only been pre-registered, with a registration deadline of 1 June 2018. For the latter substances, toxicity data are either practically non-existent (GPP and MP), or limited to very sparse toxicity data from manufacturers (BAPP).

Concerning the exposure potential, the expert appraisal has shown that most flame retardants, including those used as replacements for 1st generation flame retardants, can be found in indoor environments (air and dust); the contribution of various sources is poorly documented (upholstered furniture, electrical conduits, electronic equipment, etc.). These data are supported by a study carried out by the Agency that showed the potential for migration of most of the studied flame retardants.

Overall, the available data for the 22 substances concerning their toxicity and their impact on the environment do not make it possible to rule out effects on health and the environment.

Concerning assessment of a possible decrease in the risk of fires associated with use of flame retardants, available data do not make it possible to conclude that flame retardants in upholstered furniture for domestic use are effective.

Data on changes in the number of fires in the home vary depending on the source, and on the degree of severity. In particular, information on the origin of the fire (match, lighter, electrical failures, gas leak, etc.), or on the type of material that was first ignited (upholstered furniture, other furniture or object) are generally not recorded. It is therefore difficult to determine the actual role of upholstered furniture in the ignition and spread of fires in the home.

Data also show that the risk of fire is not distributed evenly among the population. This risk is related to multiple determinants that are rarely recorded in statistical data collected by the authorities responsible for prevention. These include age and quality of housing, the socio-demographic characteristics of victims, tobacco consumption, etc.

Regulations to reduce the flammability of domestic upholstered furniture have been implemented in certain countries, starting in 1970 in the United States, and from the early 1990s in the United Kingdom. These regulations specifically required manufacturers to produce upholstered furniture complying with standards to slow ignition of fires on fire-retardant treated items. Other measures such as anti-smoking policies, mandatory installation of battery-powered smoke detectors/alarms, information campaigns, household renovations, etc., were taken to influence these various factors that may have contributed to a reduction in the risk of fires.

However, data regarding the frequency and severity of fires following implementation of standards in the United Kingdom and the United States do not enable evaluation of the specific impact of flame retardants in the reduced frequency of fires.

As a result, the available data do not allow us to conclude that fire-retardant treatment of upholstered furniture with flame retardants significantly reduces the frequency and/or severity of household fires.

Therefore, given the health, safety, and environmental data available and the potential associated risks, the Agency cannot recommend generalisation of treatment for domestic upholstered furniture with flame retardants.

ANSES recommends that other measures to improve fire safety in housing that are likely to reduce frequency and/or severity, and that have proven their effectiveness in the countries where they have been adopted, should be given preference and reinforced. In particular, the Agency recommends:

Development of information systems on fires:

- Implementation of a systematic collection tool for information on the causes of fires and the factors that influence their development in the home. This action, which could involve a national register on the cause of fires, like the French RCCI (Search for causes and circumstances of fire), should be conducted in collaboration with the various stakeholders, including insurers, civil defence, the justice department, health services, etc.;

General measures aimed at combatting fires:

- Compliance with requirements for mandatory installation and regular maintenance of battery-powered smoke detectors/alarms (implementation mandatory in housing from March 2015[12]) ;
- Periodic testing of electrical and gas installations in individual and collective housing;
- Targeted training and improved awareness of the population about the prevention of fire hazards focused on the main factors that influence the fire risk, specifically tobacco, the condition of housing stock, heating appliances, etc.;
- Prevention campaigns regarding household fires, along with an evaluation of their results;
- Publication of a periodic report that analyses implementation of measures for fire prevention in housing.

[12] Decree 2011-36 of 10 January 2011, and Order of 5 February 2013.

Close attention should be paid to implementation of these actions concerning vulnerable populations living in degraded or dilapidated housing.

Moreover, the Agency recommends:

- Identifying substances used as flame retardants and their contents in the various treated materials, particularly those imported into the European Union. To this end, establishment of a list of flame retardants whose safety and effectiveness in real conditions of use have been demonstrated could be considered;

- Improving knowledge of the effects of flame retardants on health and the environment;

- Developing diffusion measurement methods that are more representative of real conditions of use of upholstered furniture that take into account physical changes to materials during their lifespan;

- Adjusting operating procedures for the measurement of migration and diffusion of flame retardants from the surface, in order to consider factors related to aging of treated furniture;

- Analysing the life-cycle of treated upholstered furniture to combat dispersion of flame retardants in the environment, and to improve protection of workers exposed to these substances in the recycling sector.

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KEY WORDS

Toxicity, flame retardants, household fires, upholstered furniture, persistence, bioaccumulation, biodegradation, environment.

ANNEX

List of "matrix/flame retardant" pairs most commonly used in upholstered furniture (CRD)

Acronym	Name and CAS number	Type of sample and application	Type of FR and active element
TCPP	Tris (1-Chloro-2-propyl) Phosphate (CAS 13674-84-5)	PUR PIR POLYETHER foam	Cl + P Additive
TDCPP	Tris(1,3-dichloro-2-propyl)phosphate (CAS 13674-87-8)	PUR PIR POLYETHER foam	Cl + P Additive
TPP	Triphenyl phosphate (CAS 115-86-6)	PUR PIR POLYETHER foam	P Additive
V6	2,2-Bis(chloromethyl) trimethylene bis(bis(2-chloroethyl)phosphate	PUR PIR POLYETHER foam	Cl + P Additive
TBPH	Tetrabromophthalate bis (2-ethylhexyl) (CAS 26040-51-7)	PUR PIR POLYETHER foam	Br Additive
M	Melamine (CAS 108-78-1)	PUR PIR foam	N Additive
TPP +MP	Triphenyl phosphate (CAS 115-86-6) + Melamine phosphate (CAS 20208-95-1)	Coverings such as PUR or PVC (without MP)	P + N Additive
TCP	Tricresyl-phosphate (CAS 1330-78-5)	Coverings such as PVC, PUR	P Additive
IPTPP	Tri (Isopropyl phenyl) phosphate (CAS 26967-76-0 and 68937-41-7)	Coverings such as PVC, PUR	P Additive
HBCD + Sb_2O_3	Hexabromocyclododecane (CAS 25637-99-4) + antimony trioxide (CAS 1309-64-4)	Synthetic textiles for back coating	Br+Sb Additive
DBDPE + Sb_2O_3	Bis (pentabromophenyl) ethane (CAS 84852-53-9) + antimony trioxide (CAS 1309-64-4)	Leather, polyester textiles for back coating	Br+Sb Additive
DecaBDE + Sb_2O_3	Decabromodiphenylether (CAS 1163-19-5) + antimony trioxide (CAS 1309-64-4)	Leather, polyester textiles for back coating	Br+Sb Additive
MP	Melamine phosphate (CAS 20208-95-1)	Synthetic textiles for back coating	P + N Additive

RDP	Resorcinol bis(diphenylphosphate) (CAS 57583-54-7)	Polyester textiles for back coating	P Additive
BAPP	Bisphenol-A bis (diphenylphosphate) (CAS 5945-33-5)	Polyester textiles for back coating	P Additive
THPC	Tetrakis(hydroxymethyl)phosphonium chloride (CAS 124-64-1) (PROBAN procedure)	Grafting to cellulose textiles: cotton, cotton/polyester	P Reagent
DMPPA	dimethyl [3-[(hydroxymethyl)amino]-3-oxopropyl]phosphonate (CAS 20120-33-6)	Grafting to cellulose textiles: cotton	P+N Reagent
PA/GPP	Phosphoric acid (CAS 7664-38-2) + Guanidine phosphate (CAS 5423-23-4)	Grafting to cellulose textiles: cotton	P + N Reagent
PA	Co-monomers of phosphinic acid (CAS 6303-21-5) (TREVIRA CS procedure)	Grafting to polyester cellulose	P Reagent
MP	Melamine phosphate (CAS 20208-95-1)	Incorporation of polyamide textile fibres	P + N Additive
DBDPE + Sb_2O_3	Bis(pentabromophenyl)ethane (CAS 84852-53-9) + antimony trioxide (CAS 1309-64-4)	Incorporation of polypropylene textile fibres	Br+Sb Additive
RDP	Resorcinol bis(diphenylphosphate) (CAS 57583-54-7)	Incorporation of polyester textile fibres	P Additive
BAPP	Bisphenol-A bis (diphenylphosphate) (CAS 5945-33-5)	Incorporation of polyester textile fibres	P Additive
PHFZr	Potassium hexafluorozirconate (CAS 16923-95-8)	Soaking of wool	PHFZr Additive
ZrAc	Zirconium acetate (CAS 7585-20-8)	Soaking of wool	Zr Additive