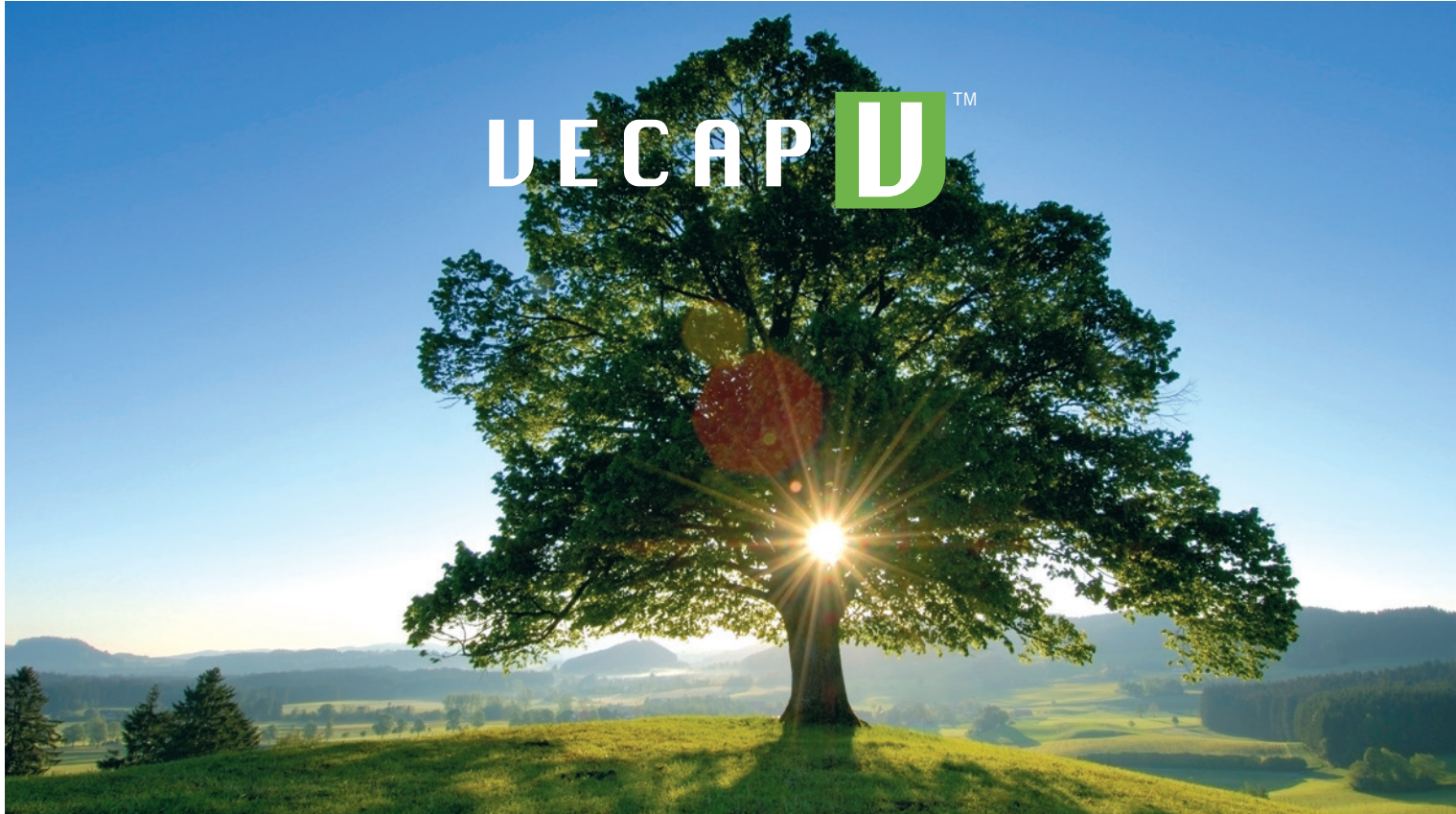


UECAP ™



The Voluntary Emissions Control Action Programme
MEASURABLE ACHIEVEMENTS

ANNUAL PROGRESS REPORT 2009





Contents

HIGHLIGHTS	02
FOREWORD	03
01. INTRODUCTION TO VECAP	04
<i>How does VECAP work?</i>	<i>05</i>
<i>VECAP methodology</i>	<i>06</i>
02. VECAP PROGRESS REPORT 2009	08
<i>Background and evolution</i>	<i>08</i>
<i>Overview of 2008-2009 Survey</i>	<i>10</i>
<i>Deca-BDE</i>	<i>12</i>
<i>HBCD</i>	<i>14</i>
<i>TBBPA</i>	<i>16</i>
03. VECAP: OUR VISION OF THE FUTURE	18
<i>Towards a global programme</i>	<i>19</i>

HIGHLIGHTS

- ① Awareness that the disposal of industrial chemical packaging is the main emission source today based on an improved understanding of packaging disposal routes
- ② Establishment of a year-on-year methodology for comparing potential emissions
- ③ The reduction of potential emission levels in 2008-2009, partially as a result of implementing VECAP best practices
- ④ Significant increases in participation and geographical coverage versus the 2008 report
- ⑤ Launch of a VECAP certification scheme: three sites have been certified so far

This report is designed to provide transparent and concise information on the progress of the Voluntary Emissions Control Action Programme (VECAP) on an annual basis. Any feedback or comment is welcome and will be considered for future editions.

FOREWORD

The Chemical Industry has a key role in helping society address challenges today and in the future. In the final report of the EU Commission's High Level Group on the Competitiveness of the European Chemical Industry, it is recognized as a "provider of solutions for a sustainable future". Of course, this does not prevent us going further through Responsible Care, our global industry's unique voluntary initiative to continuously improve performance on the environmental, health, safety and security aspects of chemical operations. 2010 marks the 25th anniversary of Responsible Care, which has not lost one ounce of its appeal to new companies and associations, due to the guidance and action that are being developed under the RC banner.

VECAP is an outstanding example of Responsible Care put into action. In 2008 it was commended by the European Responsible Care Awards Jury. The judges were impressed by the high recognition VECAP received from external stakeholders, and regarded it as a model of good cooperation between manufacturers and downstream users to enhance the safe management of chemicals. Such close engagement requires sustained efforts, which thanks to the VECAP process have opened up a much greater awareness of the real issues to address.

The data in this year's report demonstrate the progress that has been made and illustrate how the industry is reducing emissions through the implementation of VECAP's best practices. Through the VECAP programme, the industry is using its resources more efficiently, and minimising waste thanks to concrete measures. VECAP is focussed on the future, underlining its commitment to continuous advances in the reduction of emissions.

Bernhard Thier
Responsible Care Manager



01 Introduction to VECAP



The Voluntary Emissions Control Action Programme (VECAP) aims to reduce chemical emissions through a better understanding and better management of chemical substances throughout the supply chain, from the producers to the downstream users. VECAP in its current form covers producers, immediate customers and a number of second-line users (the customers of the producers' customers), who use flame retardants in their products. Today, VECAP does not deal with potential emissions during service life or at the end of life of a product, although these issues are recognised as a serious point of attention by EBFRI¹ and the brominated flame retardant industry at large.

In 2004, EBFRI members initiated VECAP to apply and further develop the best available practices in the handling of the chemicals they produce, both at the manufacturing sites and within the value chain. VECAP was developed and implemented in partnership with the flame retardant user industries and has set new standards for chemicals management in the workplace. The programme has included the education of stakeholders by organising workshops to introduce VECAP to regulators, trade groups and others interested in chemicals management. VECAP is now used by the three main

producers of brominated flame retardants as well as in more than 130 users' sites.

In 2006, SECURE², a similar product stewardship programme was set up jointly by producers of HBCD and polystyrene foam, to control and reduce potential emissions of HBCD to the environment, focussing specifically on the polystyrene foams supply chain. This programme was operated jointly by PlasticsEurope³ and Exiba⁴ (representing the polystyrene foams industry) and EBFRI. In 2007, the VECAP and SECURE programmes combined forces to identify and adopt common methodologies.

As a tool VECAP aims to reduce the emission to the environment, by:

- Implementing the VECAP best practices
- Creating and increasing awareness and understanding of chemicals management for all people involved in manufacturing: from the shop floor to the boardroom.
- Promoting and facilitating an open and constructive dialogue with all parties involved, such as industry, regulators and other stakeholders.

¹ The European Brominated Flame Retardant Industry Panel (EBFRI): www.ebfri.org

² Self Enforced Control of Use to Reduce Emissions (SECURE)

³ PlasticsEurope: www.plasticseurope.org

⁴ Exiba: www.exiba.org

HOW DOES VECAP WORK?

The driving forces behind the progress of VECAP are the members of a Product Stewardship Team which includes a Product Steward, EBFRIP members, Cefic⁵ representatives and members of the SECURE group. All of them are professionals, with knowledge of brominated flame retardant production or application processes. The VECAP Product Steward, supported by the Product Stewardship Team, develops the tools needed for the VECAP methodology, including the survey questionnaires which focus on potential emissions from process and packaging to air, water and land. Each of the three producer companies requests from its customers to complete and return them. The answers are first collated by each supplier, then consolidated by Cefic's statistical services and finally compiled and analyzed by the VECAP Product Steward.

Although working closely together, both Cefic and the VECAP Product Steward act independently of the manufacturers and users. The Cefic statistical services and the Product Steward are the only parties with access to the collated potential emissions data.

It is important to understand that VECAP does not physically measure emissions from chemical processes, but estimates the potential emissions associated with user and producer processes and practices. This ensures that a precautionary worst case scenario is taken to controlling emissions. Previously emissions control has focussed on an 'end of pipe' approach but the traditional approach can miss important emission pathways and can give a reading with limited relevance.

Under VECAP, in case no measured data is available, a worst case scenario is used and potential emissions are assumed to be being emitted unless the emissions pathway has been demonstrated to be effectively closed. These

estimations are formalised by means of questionnaires which allow the known potential emission performance at each stage in the producer or user's process to be combined to estimate total potential emissions. The questionnaires have inbuilt 'default values' for the emission performance of processes, however it is possible for the users to insert their own values if they have measurements available. The determination of the 'default values' is based on measured values from running processes. As VECAP is applied in a consistent manner, it identifies the main potential sources of emissions, and allows the impact of changes in processes to be evaluated.

A certification scheme was launched at the beginning of 2009. Three sites have since then received certification: two in Europe, one producer and one downstream user, and one US based production site.

The scheme was developed by the Product Steward in association with the environmental auditing company Bureau Veritas Certification based on ISO9001/14001 principles, with audits carried out by independent auditors. Since the program's inception, independent certification has been the ultimate step of the continuous improvement process. The certification process aims to be easy to understand. The certification scheme for SMEs applies only to the process and use of best practices, while for larger companies it can be extended to the management part in line with other standards like ISO14001 or the Responsible Care Management systems.

The EBFRIP VECAP programme focuses on brominated flame retardants and is open to all producers and downstream users. However, the VECAP methodology can be applied in principle to encourage emissions reductions of any type of solid or liquid chemical. While some individual EBFRIP member companies are applying the methodology to other chemicals, this is outside the scope of the EBFRIP programme and is not reported here.

WHAT ARE BROMINATED FLAME RETARDANTS?

There are two forms of brominated products which are found abundantly in nature: bromide salts and organobromine compounds, which are produced by many types of marine organisms. The most recoverable form of bromine is from soluble salts found in seawater, salt lakes, inland seas and brine wells. It is also present in certain rocks and in the earth's crust.

Bromine is most widely used in brominated flame retardants. In general, flame retardants render ignition of plastics, foams and textiles more difficult and slow down the spread of fire thereby allowing people to escape, providing firefighters more time and making their intervention easier. They are commonly used in many domestic and industrial appliances including: computers, TVs, mobile phones, textiles, furniture, mattresses and insulation boards. They are also used in a wide range of materials and textiles for upholstered furniture.

Three commercial brominated flame retardants are covered in this report: Deca-BDE, TBBPA and HBCD. Their specific uses are described with the survey results.

⁵ European Chemicals Industry Council (Cefic): www.cefic.org

01 Introduction to VECAP

Emissions Survey Tool

To collect the emissions information from the users, different questionnaires were developed by the Product Steward supported by the EBFIP suppliers, in collaboration with the downstream users, for each of the two types of applications: plastics and textiles. Every step in the user's process is considered in order to cover all potential emission points. As mentioned, the questionnaires focus on estimated emissions from process and packaging to air, water and land.

The questionnaires, provided by the supplier with volume data for the previous year, are submitted to the first line customers (and to second line customers where possible). The data are either based on default values, measured values supplied by the user, or a combination of both. For air and water emissions, the default average values are taken where possible from a study by a consultant, GfA⁶, or else are based on practical experience of users. For residual product left in nominally empty packaging, the brominated flame retardant producers have generated default average values for each type of packaging and product form, based on in-house or user measurements where possible.

Emissions data collection & reporting

Brominated flame retardant users are responsible for completing the questionnaire and ensuring the accuracy of the information. A report is issued by the supplier, highlighting the potential emissions identified by the survey, and recommendations are provided to the user on how best to achieve emission reductions. If indeed these recommendations are implemented, an updated emissions report is issued and sent to the user, eventually still with further recommendations. Continuous improvement is the key for this voluntary program.

Note that a full survey of every user is not undertaken each year. The team focuses their efforts on "new" participants and on those users where the largest emission reductions could be expected based on analysis of the previous year's survey.

When more than one producer is supplying to the same user, the volume supplied by each is aggregated at Cefic. The data are then treated to obtain estimated potential emissions in g/tonnes supplied in the EU. Using weighted averages, it is also possible to obtain kg/year potential emissions.

The consolidated results of the surveys dating 2008 and the first half of 2009 are presented in this report.

Providing support to Vecap users

VECAP actively supports companies in implementing the best practices and making continuous improvements. The VECAP system starts with the user's commitment to the programme, adopting the Industry's Code of Good Practice and implementing these principles into the procedures and work instructions of their daily operations. As an annex to the Code, Best Available Technique (BAT) guidance documents have been developed for emptying packaging and for the emptying of Intermediate Bulk Containers (IBC), drums or containers efficiently.



ESTIMATION OF EMISSIONS FROM PROCESS WASTE

Understanding the disposal methods for process wastes is an important aspect of the VECAP process. Process wastes are considered as being potential emissions if:

- Waste goes to uncontrolled landfill i.e. it is in a site that is not licensed to accept hazardous waste as outlined in the Landfill Directive (1999/31/EC). These are considered as potential emissions to land.
- Packaging waste goes to recycling, unless the recycling practices are known and "VECAP compliant". These potential emissions can be to air, land or water. However, to simplify, our methodology considers these as potential emissions to land.

If waste is incinerated or routed to a controlled landfill that is licensed to accept hazardous waste according to the Landfill directive 1999/31/EC, it is not considered as a potential emission. If a user does not know how his waste is being handled, the VECAP programme errs on the side of caution in that it reports such cases as a potential emission until clarification is obtained.

⁶ GfA reports: 60425-011.B14, 10 September 2003 (Deca-BDE); 60425-011.B13, 21 August 2003 (HBCD)

THE VECAP METHODOLOGY

1 Self audit

Through the self-audit the company verifies the production flow sheet of its operations. The process flow chart developed by VECAP may assist users in identifying where the potential material losses can occur within the processes.

2 Mass Balance Approach

The company completes the product mass balance, which indicates the data that should be measured, recorded and managed. This signals the gap in the amount of product entering and leaving the production process.

3 Baseline Emissions Survey

The company uses the obtained results as a baseline to demonstrate actual performance and to detect future priorities for improvement in chemicals management.

4 Chemical Management Improvement Plan

An emission reduction plan is determined in line with the company's own objectives and policies in close cooperation with the VECAP and Secure product stewardship team.

5 Implementation and continuous improvement

Once the improvement plan is implemented, operational results are evaluated and potential for further emission reductions investigated, ensuring effective continuous improvement. VECAP has produced a number of tools that participating companies can use to implement the VECAP best practices.

02 VECAP progress report 2009



BACKGROUND AND EVOLUTION

At its creation in 2004, VECAP focused on Deca-BDE. Over the past five years, VECAP has expanded its coverage to include also HBCD and TBBPA, as these three chemicals are common to the EBFRIIP members.

During the early years of the programme, there was an exclusive focus on potential user emissions to air and water, mainly because regulators had expressed concerns for these media and had asked EBFRIIP to monitor and report progress in this area. The 2008 annual report highlighted the emerging issue of the potential for emissions to land from residues in packaging waste. The issue of potential emissions from packaging waste had been identified in 2007 through VECAP's process of seeking to calculate the emissions potential for 100% of the chemical. At that time, the levels of residue in used packaging materials were not regarded as an issue and were not being quantified by any process. Initial calculations indicated residual levels in packaging wastes were highly variable. Whether such residues should be considered as potential emissions depends on the fate of the used packaging, and whether disposal is carried out in a controlled or uncontrolled way. If there are potential emissions their level depends strongly on packaging type, as well as on the means of storage and disposal.

Having recognised this issue, the Product Steward and the the Product Stewardship team built up appropriate questionnaires so the issue could be addressed fully in the

2008 survey. This survey confirmed that disposal of packaging waste containing brominated flame retardant residues was indeed a significant issue and that the level of potential emissions was actually much higher than the potential emission levels estimated from the processes to air and water. The issue of the packaging waste residues disposal is now addressed through the implementation of the VECAP best practices by a majority of users as seen in this report.

In addition to the use of improved questionnaires, the team also developed a database for combining, analysing and reporting emission levels from the whole market, maintained independently by the Cefic statistical service. These measures will allow consistent and comparable reporting in future years.

It should be noted that, inevitably, the continuous evolution of the programme, and particularly the discovery of an additional source of potential emissions, makes year on year comparisons difficult.

CONTINUOUS INCREASE IN VECAP PARTICIPATION

VECAP's growth is illustrated by the substantial increase in the number of participants surveyed in the VECAP programme in Europe. From an initial 80 sites in six EU countries, VECAP has grown to cover 135 participating sites in Europe. Together these sites handle 85% of the total volume of the three brominated flame retardants that EBFRIIP members sold in 2007. The breakdown of participation by users of the three products covered in this report is shown in Figure 1 below.

Figure 1: VECAP survey participation

Product	% of brominated flame retardant volume consumption	Number of user sites
Deca-BDE	76% (incl. 9% from second line users)	58 of 92 (incl. 27 second line users)
HBCD	93% (incl. 4,5% from second line users)	60 of 73 (incl. 2 second line users)
TBBPA	89%	17 of 23

It should be noted that these participation figures relate only to the users and volumes supplied by the EBFRIIP member companies. Volume supplied by non-EBFRIIP

members cannot be included, but we have no reason to believe its treatment by the users will be significantly different from volume supplied by EBFRIIP members, provided the programme was introduced to those users

Most of the survey participants are also committed to the VECAP programme, by which we mean they sign up to the codes of good practice and take whatever steps they can to reduce levels of potential emissions. The commitments from users of the three brominated flame retardants covered in this report are shown in Figure 2 below.

Figure 2: Commitment to the VECAP programme

Product	% of brominated flame retardant volume consumption
Deca-BDE	66% (54% VECAP, 12% TFA ⁷)
HBCD	90%
TBBPA	84%

⁷ The origins of the VECAP programme lie with the UK Textile Finishers Association (TFA), who in 2004 initiated a Code of Good Practice that called on the UK textiles industry to audit their processes, and take action to reduce Deca-BDE emissions from their processes.

Case Study

HBCD: Eliminating uncontrolled landfilling

A downstream HBCD user had identified in an initial survey potential emissions of 1148 kilograms per year. These potential emissions were due to the empty packaging being sent to an uncontrolled landfill, which under the VECAP programme is considered as a potential source of emissions.

As part of its improvement plan the company implemented the VECAP best practices for the handling of empty packaging. By sending its empty packaging to controlled landfill or an incineration plant the potential emissions have been effectively eliminated.

OVERVIEW OF 2008-2009 SURVEY

KEY FINDINGS

Based on the data gathered from 135 users' sites surveyed, there are two headline findings:

- ① The disposal of used packaging containing residues is a much more important issue than had been realised until now and the associated potential emissions to land are much higher than those to air and water. This finding is a very important step towards achieving better control of emissions.
- ② There is a reduction in the level of potential emissions reported for 2009 compared to 2008. An important part of the reported reduction can be attributed to the adoption of best practices for disposal of used packaging in 2009. However, a substantial part of the reduction is due to the fact that, at some users we assumed worst-case conditions in 2008, in accordance with the VECAP methodology, when those users did not know the fate of their used packaging. In some cases, the disposal conditions were subsequently found to be already in accordance with the VECAP best practices. As a result, the overall 2008 potential emissions are over-estimated.

For all three products (Deca-BDE, HBCD and TBBPA), as shown in the detailed results in figure 3 and 4, potential emissions to land account for the largest share overall, with potential emissions to air and water being comparatively small. For all three substances, packaging waste is identified by the VECAP programme as the main

contributor to potential land emissions due to uncontrolled landfill or composting, to recycling of empty paper packaging, to the packaging waste going to unknown destinations or to the unprotected storage of packaging. The implementation of VECAP best practices has led to a substantial reduction in total emissions.

Figure 3: VECAP 2008 Survey

Product	Total volume sold (2007 figures)	Total potential emissions (2008 survey)	Potential emissions (in g/tonne sold)
Deca-BDE	5767 tonnes	3432 kg	600 g/tonne
HBCD	10897 tonnes	2017 kg	200 g/ tonne
TBBPA	4165 tonnes	815 kg	200 g/ tonne

Figure 4: VECAP 2009 Survey

Product	Total volume sold (2008 figures)	Total potential emissions (2009 survey)	Potential emissions (in g/tonne sold)
Deca-BDE	7030 tonnes	1220 kg	175 g/tonne
HBCD	8913 tonnes	309 kg	30 g/tonne
TBBPA	3224 tonnes	189 kg	60 g/tonne

The 2008 and 2009 survey results show that VECAP has been able to report a considerable and demonstrable reduction in total emissions. This has been possible thanks to the identification in 2008 and tackling in 2008-2009 of new emissions sources, mainly from packaging waste disposal practices, as first mentioned in the 2008 Annual Progress Report. This is a key finding, because it shifts the focus for action away from re-engineering the plant, and towards more basic improvements in materials handling practices, with high potential to reduce emissions. The best practices for packaging handling include simple measures to ensure complete emptying, and controlled disposal, all of which can be implemented at low cost with high potential benefit in terms of reduced emissions to the environment.

It is important to note that in the 2008 survey, the worst case scenario was applied whenever users had no information on the packaging waste disposal route, this being part of the methodology. The Product Stewardship team has since then been able to clarify these unknown situations, either directly with the

users, or through investigations with waste handling companies. This has allowed refinements, and in some instances notable reductions, in VECAP's emissions estimations.

The emission reductions that are highlighted in the above tables are therefore partially due to the clarifications. In the reporting for Deca-BDE, for example, it was learned through the VECAP process that around half the reported emissions reduction can be associated with the assumption of a worst-case scenario in 2008. This can be considered as a success for the VECAP programme, as the reductions which can be attributed to the introduction of best practices are considerable, and the level of downstream user awareness of the consequences of packaging waste disposal has progressively increased. In the coming year, in order to bring more clarity, VECAP will work on refining the data in order to segregate and quantify the emissions reductions resulting from the implementation of the best practices.

DECA-BDE

2008 SURVEY RESULTS FOR DECA-BDE

These results are for the survey carried out in 2008, based on the volume sold in 2007.

Total potential emissions for Deca-BDE in 2008 are estimated to be 3432 kilograms, less than 0.1% of the 5767 tonnes sold by EBFRIP member companies in 2007.

Potential emissions to air and water are estimated at 42 and 81 kilograms respectively. Plastics compounding and textile formulation each accounted for approximately half of the potential emissions to air, whereas the largest share of potential emissions to water originated from textile formulations.

Figure 5: Deca-BDE 2008 survey results

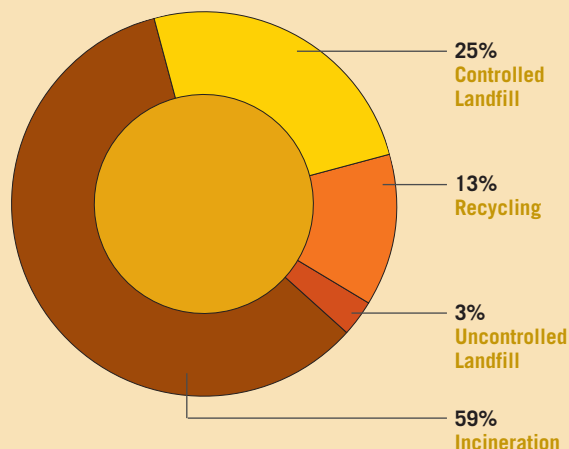
	Air	Water	Land
Potential Emissions	42kg/year	81kg/year	3309kg/year

Potential emissions to land are estimated to be considerably higher with 3309 kilograms in 2008. The extent to which used packaging material is handled in line with VECAP best practices impacts greatly on the total potential emissions to land.

Destination of empty Deca-BDE packaging

VECAP best practices recommend used packaging material to be either incinerated or disposed of in controlled landfill. The 2008 Survey demonstrated that 84% of the Deca-BDE volume covered was handled according to best practices. The remaining 16% was dealt with through recycling and uncontrolled landfill, thereby considered under VECAP as a potential source of emissions to land. Given that the 2008 Survey covered 67% of the volume sold by EBFRIP member companies, the conclusion is that for 56% of Deca-BDE the used packaging has been handled in accordance with best practices.

**Chart 1: Survey 2008 (Volumes 2007)
Destination of empty Deca-BDE packaging**



WHAT IS DECA-BDE?

Deca-BDE is a flame retardant used in many domestic and industrial appliances and equipment. It is highly effective in increasing resistance to fire and allows up to 15 times more time to escape when a fire occurs. Comprehensive and extensive evaluations and risk assessments have concluded that Deca-BDE presents no significant risk for the environment or human health.

Deca-BDE is used in plastics for electric and electronic equipment (with the exception of Europe since 1.7.2008), in the transportation sector (e.g. automotive and aviation industries) and in construction and building (e.g. wires, cables, pipes). It is also used as a flame retardant in textiles to enable upholstered furniture to comply with fire safety standards for public places and buildings.

The use of Deca-BDE ensures compliance with the most stringent fire safety requirements for home furniture in Ireland and the United Kingdom. Statistics for the UK alone estimate that over 4,000 lives have been saved since 1988 as a result of legislation mandating that upholstered furniture be made with a high level of fire resistance⁸. In the United States, similar fire safety requirements exist in California.

⁸ "Effectiveness of the furniture and furnishings fire safety regulations 1988", second report of UK Department of Trade and Industry, June 2000

2009 SURVEY RESULTS FOR DECA-BDE

These results are for the survey carried out in 2009, based on the volume consumption in 2008.

Following the 2008 findings, the implementation of the VECAP best practices in areas we had discovered a high level of potential emissions has been a top priority for the Product Stewardship Team. Thanks to the increased uptake of best practices, we have achieved a noteworthy reduction in potential emissions. Potential air emissions were reduced by 10 kilograms to 32 kilograms. The potential water emissions were reduced by 15 kilograms

to 66 kilograms. The largest reduction was to be found in land potential emissions, where they reduced to 1122 kilograms, only 0.02% of total production in Europe. This demonstrates a significant emission reduction when compared to the 3309 kilograms identified in the 2008 survey. However it is important to note that although a significant part of this reduction was a result of the introduction of best practices, a notable part was also due to overestimates made at that time by our adopting a worst case scenario at some users, due to their lack of knowledge on the packaging waste disposal routes.

Figure 6: Comparative Deca-BDE survey results for 2008-2009

Deca-BDE	Air	Air	Water	Water	Land	Land
Survey year	2008	2009	2008	2009	2008	2009
Volume from year	2007	2008	2007	2008	2007	2008
Total Potential Emissions	42 kg/year	32 kg/year	81 kg/year	66 kg/year	3309 kg/year	1122 kg/year
Emissions in grams tonne sold	7 g/tonne	5 g/tonne	14 g/tonne	9 g/tonne	575 g/tonne	160 g/tonne

Note that the reductions in total potential emissions were achieved in spite of a rise in Deca-BDE sales, whose volume was increased by 22% between the 2008 and 2009 surveys.

Case Studies

Deca-BDE: Reduction of potential water emissions

At the start-up of a new production line a large European compounder and master batch producer discovered a potential emission to water of 50 kilograms per year, as a result of Deca-BDE settling in the cooling water and the circulating water of the equipment.

Following the installation of a filter in the water circulation system, most of the Deca-BDE is now removed and disposed of as chemical waste. As a result of this improvement the potential emission to water is less than 36 grammes per year, which is equivalent to a reduction of 99%.

Deca-BDE: Reduction of potential air emissions

Dusty operations resulted in more than 100 kilograms per year of potential air emissions being identified at a Deca-BDE user site. Following VECAP best practices, ventilation and filter systems were installed, which resulted in a reduction by 98% of air emissions.

HBCD

2008 SURVEY RESULTS FOR HBCD

These results are for the survey carried out in 2008, based on the volume consumption in 2007. The VECAP/SECURE survey covers 60 out of 73 HBCD user sites representing 93% of the total volume sold by EBFRIIP members in 2007 (10,897 tonnes).

Moreover, 90% of the volume sold is now covered by either VECAP or SECURE commitment, meaning that the Code of Good practice has been signed. This highlights the good uptake of the VECAP principals and gives us confidence that the Product Stewardship message has been widely accepted and operationally implemented.

Potential emissions to air and water in 2008 are estimated at 87 and 73 kilograms respectively. The total

of potential land emissions is of 1857 kilograms, or 0.02% of volume sold.

Figure 7: HBCD 2008 survey results

	Air	Water	Land
Potential Emissions	87Kg/year	53Kg/year	1857Kg/year

The main part of these emissions goes to land. This is a finding which was not apparent at the time the EU HBCD Risk Assessment was finalised in 2008, and places a new perspective on how HBCD emissions can most effectively be controlled.

WHAT IS HBCD?

Hexabromocyclododecane (HBCD) is a flame retardant used mainly in thermal insulation foams, and to a lesser extent in textile coatings. For foams in particular, HBCD is a unique flame retardant used to protect human lives and property from fire. HBCD's main use is in Expanded and Extruded Polystyrene (EPS and XPS) insulation foam boards which are widely used by the construction sector. EPS and XPS insulation foams make a key contribution in helping governments to meet an important part of global, regional and national energy efficiency targets. In Europe, PS insulation foams are indispensable for the implementation of the EU Directive on energy performance in buildings (2002/91/EC). This is thanks to the eco-efficient and excellent thermal insulation performance to thickness ratio of EPS and XPS foams.

EPS and XPS foams have to meet stringent fire safety regulations in a number of EU countries. The use of flame retarded EPS and XPS insulation foams is essential for achieving these standards in construction. HBCD provides a high degree of flame retardancy when used at relatively low concentrations. Furthermore, foams using HBCD are both mechanically & thermally recyclable.

A further minor application of HBCD is in HIPS (high impact polystyrene) which is used in electrical and electronic equipment and appliances (e.g. audio visual equipment).

HBCD is also applied in the back coating of textiles, mainly for upholstered furniture. It is one of the flame retardant technologies used to meet the highest levels of fire safety required by legislation for furniture and other textile applications in public places in several EU Member States.

HBCD has undergone a European Union risk assessment for environment and human health under regulation (EC) 793/93⁹. Following the risk assessment, finalised in June 2008, HBCD has been identified as a PBT substance, based mainly on findings of HBCD in wildlife distant from its actual use and trends of increasing concentrations in the environment. As a result of the PBT designation, HBCD was identified as a Substance of Very High Concern (SVHC) under the REACH¹⁰ regulation and included on the candidate list for Authorisation.

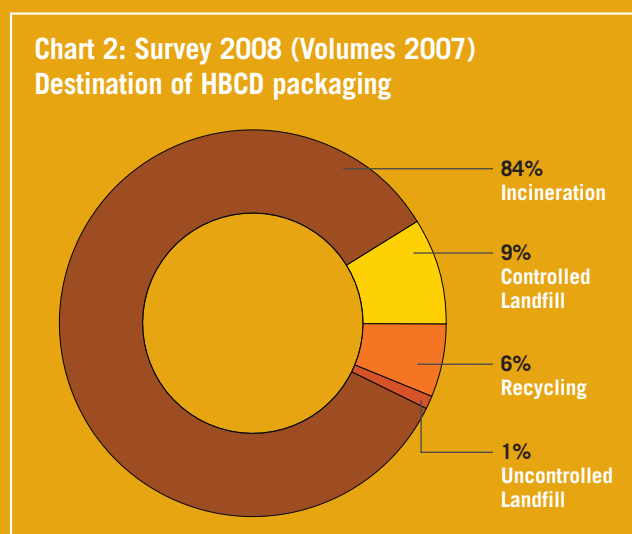
The European HBCD industry is cooperating closely with all the relevant European authorities to reduce the risks identified for the environment, and this is driving the VECAP/SECURE programmes for that substance.

⁹ Council Regulation (EEC) No 793/93 on the evaluation and control of the risks of existing substances

¹⁰ Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation (EC) 1907/2006

Destination of HBCD packaging

Overall, for 93% of the volume of HBCD surveyed, packaging waste is handled using the VECAP best practices, 84% through incineration and 9% by controlled landfill. The packaging waste disposal of only 7% of the volume surveyed is responsible for the large majority of the potential emissions. As the data represent 84% of the volume sold by EBFRIIP, we can conclude that 78% of the volume is handled according to the VECAP best practices.



2009 SURVEY RESULTS FOR HBCD

These results are for the survey carried out in 2009, based on the volume sold in 2008.

The total volume of HBCD sold by EBFRIIP member companies in 2008 was 8913 tonnes. Following the 2008 findings, the implementation of the VECAP best practices in areas where we had discovered a high level of potential emissions has been a top priority for the Product Stewardship Team. Thanks to the increased uptake of the VECAP best practices, we have achieved a notable reduction in land emission compared to 2008 survey figures. There is overall a very clear reduction of potential emissions, thanks to the identification of further sources of potential emissions and the implementation of the best practices in both emptying of packaging and processing of substances.

We note the reduction by 33 kilograms of potential emissions in the air, so to 54 kilograms per year. The most important reduction is seen in land potential emissions, where they were reduced from 1857 kilograms to 196 kilograms per year.

Figure 8: Comparative HBCD survey results for 2008-2009

HBCD	Air	Air	Water	Water	Land	Land
Survey year	2008	2009	2008	2009	2008	2009
Volume from year	2007	2008	2007	2008	2007	2008
Total Potential Emissions	87 kg/year	54 kg/year	73 kg/year	59 kg/year	1857 kg/year	196 kg/year
Emissions in grams tonne sold	8 g/tonne	6 g/tonne	7 g/tonne	7 g/tonne	170 g/tonne	22 g/tonne

Note that HBCD sales volume was reduced by 18% when comparing the 2008 and 2009 surveys. Nevertheless, the total potential emissions were reduced by 85% in the same period.

It is again important to note that in the 2008 survey, the worst case scenario has been applied when users had no information on the packaging waste disposal route, as per the VECAP methodology. The emission reductions that are highlighted in the above table are therefore partially due to the refinements that were allowed when clarifications were obtained.

TBBPA

2008 SURVEY RESULTS FOR TBBPA

These results are for the survey carried out in 2008, based on the volume consumption in 2007.

The VECAP survey covers 17 out of 23 TBBPA user sites, representing 89% of the total volume sold in 2007 in Europe by the EBFRIIP producers. The survey is further supported by a written commitment to VECAP for 84% of the volume. In total, the volume sold by EBFRIIP in 2007 was 4,165 tonnes.

The potential air emissions are 32 kilograms, 97 percent of which is produced by the plastics compounding industry (an additive use of TBBPA). The potential for emissions to water is estimated at 59 kilograms, virtually all from plastics compounding. The potential land emissions are very much higher at 724 kilograms. These emissions are mainly due to packaging waste disposal.

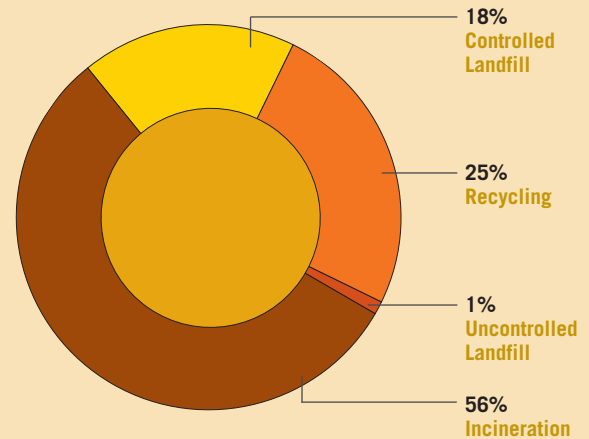
Figure 9: TBBPA 2008 survey results

	Air	Water	Land
Potential Emissions	32Kg/year	59Kg/year	724Kg/year

Destination of TBBPA packaging

Most packaging disposal is via controlled incineration, with significant amounts also by recycling and controlled landfill. The packaging disposal of 74% of the volume surveyed is handled using the VECAP best practices. 56% of this is handled through incineration and 18% is disposed of by controlled landfill. As these data represent 82% of the volume sold by EBFRIIP, we can conclude that 66% (74% of 82%) of the volume is handled with best practices.

**Chart 3: Survey 2008 (Volumes 2007)
Destination of TBBPA packaging**



WHAT IS TBBPA?

TBBPA is the brominated flame retardant with the largest global production volume today and is used to improve fire safety, mainly of printed wiring boards (PWBs) in electrical and electronic equipment.

TBBPA contributes to the fire safety of electrical and electronic equipment and installations where printed circuit boards are used, such as consumer electronics (TVs, vacuum cleaners, washing machines), office and communication equipment (for example photocopiers, computers, printers, fax machines, radios), automotive, mass transportation, aviation and entertainment equipment.

The main application of TBBPA is in laminates used for PWB. In this application TBBPA is used as a 'reactive' flame retardant; it therefore no longer exists as a free chemical in the final board but forms part of the polymeric resin. It is used in more than 90% of FR-4 printed circuit boards, the most commonly used board in electronic devices.

TBBPA is also used as a non-reactive 'additive' flame retardant mainly in acrylonitrile butadiene styrene (ABS) which is a common thermoplastic used to make light and rigid moulded products such as electrical & electronic equipment exterior casings.

In addition, TBBPA is used as an intermediate in the production of other brominated FR systems, derivatives and brominated epoxy oligomers where it is integrated into the resin as well.

2009 SURVEY RESULTS FOR TBBPA

These results are for the survey carried out in 2009, based on the volume sold in 2008.

The 2009 results are very positive and highlight the high level of implementation of the VECAP best practices. We have seen a clear change in the potential emissions levels in air, water and land. This has been aided by further identification by the VECAP team of new potential sources of emissions, which have been addressed.

The total volume sold by EBFRIIP members in 2008 was 3,224 metric tons. The potential emissions to air were reduced by over 95 percent, from 32 kilograms in the

2008 survey to 0.5 kilograms in 2009. The same pattern can be observed for potential water emissions, which were reduced to 0.4 kilograms. Although less dramatic in percentage terms, the reduction of potential land emissions in absolute terms is very large (down from 724 kilograms to 188 kilograms). Once again, parts of these reductions are due to application of the worst case scenario in the initial survey, in cases where the final destination of packaging waste was unclear. Another reason for the reduction is the closure in 2008 of one of the user's sites. This site happened to report rather significant water emissions as can be seen in the 2007 potential emissions.

Figure 10: Comparative TBBPA survey results for 2008-2009

TBBPA	Air	Air	Water	Water	Land	Land
Survey year	2008	2009	2008	2009	2008	2009
Volume from year	2007	2008	2007	2008	2007	2008
Total Potential Emissions	32 kg/year	0.5 kg/year	59 kg/year	0.4 kg/year	724 kg/year	188 kg/year
Emissions in grams tonne sold	8 g/tonne	0.2 g/tonne	14 g/tonne	0.1 g/tonne	175 g/tonne	58 g/tonne

Note that TBBPA sales volume was reduced by 33% compared between the 2008 and 2009 surveys.

Case Study

Implementation of new practices inspired by VECAP programme

The textile formulator CTF 2000 is the first downstream user to be certified under the VECAP programme. Through the implementation of the VECAP best practices, CTF 2000 have organized the collection of textile formulation process residues at their downstream users and are able to re-use the waste water containing this formulation.

About 5% of the textile formulation can be recovered through the proper emptying of the containers ensuring the recovery of a further 10 kilograms Deca-BDE per container. By implementing this procedure, CTF 2000 has achieved a major reduction in potential emissions that could result from disposal by their downstream users of textile formulation waste to the environment.



Since its creation five years ago, VECAP has seen a tremendous growth. As a groundbreaking process VECAP has improved the way users and producers manage brominated flame retardants in terms of product stewardship. Throughout the programme, participants have been able to identify the critical points in the handling process that are potential sources of undesired emissions. Thanks to this basis of knowledge the producers have developed tools and proposed measures to make continuous improvement and consequently reduce the emissions.

Looking ahead, EBFRIIP member companies wish to build on these achievements with the aim of progressing in the management of brominated flame retardants' production and use. Through VECAP, participants commit themselves to the responsible management of chemicals and state that the VECAP process is enabling them to make tangible improvements.

In the context of continuous improvement, there are a number of areas where the team wishes to make further progress over the next five years period.

1 Focus on addressing used packaging as the main source of potential emissions

A major accomplishment of VECAP has been to identify the main potential sources of emissions. In particular, the handling of used packaging was a major source that had not been considered as an area of attention until it was identified in 2008. Handling, storage and correct disposal of used packaging will remain our focus during the coming year, and most attention will be given to those users where considerable potential emissions have been identified.

2 Increase VECAP coverage to non-EBFRIIP members

The team will continue to promote the use and benefits of VECAP with the aim of increasing the participation of brominated flame retardant users. A further key challenge will be to involve those producers who are not members of EBFRIIP, and to engage their user chain.

3 Increase VECAP coverage in the UK textiles industry

The UK Textile Finishers Association (TFA) was the original founder of the VECAP programme, and has thus far provided UK inputs to the programme. Sadly, the TFA ceased to exist in 2009, and as a result the VECAP team will now take on the task of promoting VECAP in the UK textiles industry directly via member company users.

4 Enhancing the development and exchange of best practices

VECAP has developed external tools in the form of best practices documents. In the light of new findings these will be reviewed and updated. With a number of best practices documents already available, a key component of VECAP over the next 5 years is to contribute to an increased awareness and application of these tools. At the same time, VECAP is considering how experiences and best practices can best be shared among the different users of brominated flame retardants.

5 Continuous improvement in data handling

Data provide the backbone of VECAP, and the availability and quality of the data determines the quality of the programme. However the progressive expansion of the scope of the programme, and the improvements in identifying and quantifying potential sources of emission,

have thus far made it difficult to compare year-on-year data. VECAP will continue to seek and address further sources of emissions but, with the introduction in 2009 of clear protocols and an independent database, the comparability of emissions data year-on-year should be assured.

6 Widen scope to encompass other materials

While its application in the context of EBFRIP is restricted to emissions control for brominated flame retardants, the VECAP methodology is suitable for use to control emissions in a wide range of substances. The methodology has already been used for other products by individual EBFRIP member companies. We are currently opening the scope so the process can be used by other companies and industries.

TOWARDS A GLOBAL PROGRAMME



The European VECAP programme has been adapted and is being introduced in North America and Japan.

In North America, Environment Canada has used the core VECAP program and principles as the basis of a formal Environmental Performance Agreement, designed to manage emissions of Deca-BDE in Canada. Also, a major VECAP participant in the USA has been honoured by an environmental award from the Society of Plastics Engineers.

In Japan, VECAP is focused today on HBCD, and involves producers and users from the textiles and polystyrene foam industries. This programme is managed in close cooperation with the Japanese governmental authorities.

ABBREVIATIONS

BAT	Best Available Techniques
BSEF	Bromine Science and Environmental Forum
CEFIC	European Chemical Industry Council
CoGP	Code of Good Practice
Deca-BDE	Decabromodiphenyl ether
EBFRIP	European Brominated Flame Retardant Industry Panel
HBCD	Hexabromocyclododecane
HPV	High Production Volume chemicals (> 1000 tons)
IBC	Intermediate Bulk Containers
REACH	EU Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals
TBBPA	Tetrabromobisphenol-A
VECAP	Voluntary Emissions Control Action Programme

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VECAP is a voluntary initiative of the European Brominated Flame Retardant Industry Panel (EBFRIP) together with the industry's global organisation, the Bromine Science and Environmental Forum (BSEF)

