MAKING AN IMPACT. VECAP was created with a mission to increase awareness of chemical handling processes through the value chain. To the participating companies, this mission is just the beginning — because by raising awareness, we encourage meaningful change; and through change, progress happens. As we share our 2012 North American results with you, we’re proud to report that we’re moving beyond awareness and having a significant effect on emissions reduction.

Contents

1 HIGHLIGHTS
2 RESPONSIBLE CARE® AND VECAP
3 I. INTRODUCTION TO VECAP
   5 Background and evolution
   5 How does VECAP work?
   5 VECAP certification
   6 The VECAP team and emissions survey tool
   6 Emissions data collection and reporting
   6 Providing support to VECAP users
9 II. VECAP PROGRESS REPORT 2012
   9 Overview of the 2012 survey
   9 Key findings
10 Deca-BDE
13 HBCD
14 TBBPA
16 III. OUR VISION FOR THE FUTURE

This report is designed to provide transparent and concise information on the progress of the Voluntary Emissions Control Action Program (VECAP) in North America. Feedback or comments are welcome and those submitted will be considered for inclusion in future reporting publications.

All information acquired from the companies that participate in VECAP is managed in full compliance with anti-trust regulations. All data is managed by an independent third party. Only data that has been aggregated by the independent third party is shared among the companies. The VECAP independent third party is the only entity with access to the confidential potential emissions data of all participants.
HIGHLIGHTS

Through the application of VECAP principles, the collective effect of shared best practices and a high commitment to certification-based compliance, 2012 was a successful year marked by continued improvement. Highlights include:

- The overall trend of reduction in the potential emissions of flame retardants (Deca-BDE, HBCD and TBBPA) has continued due to the application of VECAP principles;

- Seven manufacturing sites and five use sites maintained VECAP certification, representing the highest possible level of commitment to the program’s objectives;

- TBBPA users are implementing best practices at a high level, leading to 100% controlled packaging waste disposal; and

- Research to date indicates that U.S. users are following best practice recommendations by disposing of waste packaging using chemically secure landfills or incineration.
**Responsible Care® and VECAP™**

VECAP is an example of Responsible Care® in action. Responsible Care® was launched in 1985 by the Canadian Chemical Producers’ Association (CCPA). It is a unique initiative for the safe and environmentally sound management of chemicals that has spread to more than 50 countries around the world and has taken firm root in the United States. Based upon the Canadian program, the American Chemistry Council® (ACC – formerly the Chemical Manufacturers Association) launched the U.S Responsible Care initiative more than twenty years ago to ensure that health, safety, security and protection of the environment are top priorities of the chemical industry. Participation in the Responsible Care initiative is mandatory for members of the ACC. Widely recognized as one of the largest and most successful voluntary performance initiatives advanced by any industry, Responsible Care® helps North America’s leading chemical companies go above and beyond government requirements, and collectively share their progress with the public.

VECAP aligns well with the tenets of Responsible Care®, as it offers a structured approach to meet the program’s desire for the safe and environmentally sound management of chemicals. Application of VECAP principles is a tangible and visible demonstration of a company’s commitment to Responsible Care®.
I. INTRODUCTION TO VECAP

VECAP is an innovative, excellence-driven way of managing chemicals. For companies committed to acting in the best interests of society and the environment, the program is a platform for proactive involvement — an opportunity to both raise awareness around potential emissions and contribute to practical, effective solutions. Through the participants’ actions, VECAP works to reduce emissions of polymer additives by promoting environmental and process best practices throughout the value chain, from producers to downstream users. Ultimately, VECAP is about generating results that benefit all stakeholders.

In North America, VECAP aspires to set new standards for chemical management in the workplace, both at manufacturing sites and within the value chain. It offers companies of every size equal access to industry expertise in environmental best practices, while setting benchmarks for other industries to apply similar principles. VECAP represents a voluntary and proactive effort to reduce emissions beyond the required North American regulatory standards. VECAP is now implemented in all manufacturing plants for Deca-BDE, HBCD and TBBPA by the three main producers of flame retardants globally.

Fire continues to be a very real problem in our modern society. There are daily threats to human life and property due to uncontrolled fire and, when fire does occur, the losses can be catastrophic. These three chemicals provide an added layer of protection to enhance fire safety in our everyday lives. Deca-BDE is a very versatile flame retardant that is used to flame-retard plastics that go into electrical items like appliances, connectors and consumer electronics, as well as various construction materials and textile coatings. HBCD has been widely used as a flame retardant for styrenic-based foams used for insulation that improves the energy efficiency of our homes and businesses. TBBPA is the primary flame retardant used to manufacture printed wire boards and other plastic composites.

The VECAP program focuses on both producers and downstream users of flame retardants. However, in principle, the VECAP methodology can be applied to encourage emission reductions of any type of solid or liquid chemical. In fact, member companies have started to apply the methodology to other flame retardants and chemicals substances beyond brominated flame retardants (BFRs).

VECAP is a tool for reducing environmental emissions by:
- Increasing understanding of chemicals management in the value chain beyond existing legislation;
- Promoting and facilitating open and constructive dialogue with all interested parties, such as industry, regulators and other stakeholders;
- Raising awareness among all those involved in the process, from the shop floor to the boardroom; and
- Implementing best practices identified through the development of the program.
BACKGROUND AND EVOLUTION

The origins of VECAP lie with three member companies of the European Flame Retardant Association (EFRA)3, which, in 2004 and in partnership with the UK textile industry, developed a code of good practice for Deca-BDE. The code of practices was then used by the textile industry to assess its processes and take actions to reduce emissions. Subsequently, over the following six years, VECAP was extended to include HBCD and TBBPA and, at the same time, was expanded to North America and to flame retardant manufacturing plants worldwide.

The program was launched in North America in 2006. Since then, a significant number of Deca-BDE, HBCD and TBBPA users in the United States and Canada have committed to implementing VECAP. This is the fourth progress report published by the North American VECAP team, following three previous reports summarizing results between 2006 and 2010.

HOW DOES VECAP WORK?

The VECAP process is driven by the principle of continuous improvement by seeking opportunities to update the program methodology to better address any new issues that may arise.

In general, flame retardants are derived from naturally occurring elements that are incorporated into materials such as plastics, foams and textiles. Flame retardants perform several vital functions; delaying the start of a fire, slowing the combustion process, and, in some cases, causing the fire to self extinguish. Since flame retardants reduce the risk of a fire spreading, people have more time to escape from fires and firefighters have more time to respond. Flame retardants are commonly used in many domestic and industrial appliances such as computers, TVs, mobile phones and insulation boards in order to comply with fire safety standards. A wide range of materials and textiles for mattresses and upholstered furniture also contain flame retardants. Three flame retardants are covered by this report: Deca-BDE, TBBPA and HBCD. Each chemical’s specific uses are described in its respective section of the survey results.

VECAP does not rely upon the physical measurement of emissions from chemical processes; rather, it estimates potential emissions through practical experience, modeling and studies. These estimates are obtained through users’ responses to questionnaires. Though it is possible for users to insert their own values whenever they have measured data available, the questionnaires utilize “default values” for estimating the emissions from processes where actual values are not determined. Default values are based on values measured during operating processes and through modeling.

The traditional methods of controlling emissions focuses on the treatment of waste streams from the process. However, this approach can miss significant steps in the waste generation process. The VECAP methodology allows companies to identify possible emission sources throughout the use cycle of a product, and implement measures to reduce or avoid emissions.

VECAP CERTIFICATION

Companies participate in VECAP by working to reduce emissions of flame retardants in their manufacturing plants. The next step in the evolution of VECAP at a use site is to work towards incorporating VECAP into management systems to aid its long-term success. In 2008, a certification plan based upon ISO 9001/14001 principles was launched. This plan was developed in association with Bureau Veritas4, with environmental audits carried out by independent auditors. Since the inception of VECAP, independent certification has been the final step in demonstrating a commitment to a continuous improvement process inherent in VECAP. The certification process is designed to be easy to follow. The certification plan for small and medium enterprises (SMEs) incorporates only the VECAP process and use of best practices, while larger companies can also include VECAP principles in written management systems to align with other standards like ISO 14001 or Responsible Care® management systems.

By the end of 2012, twelve sites had maintained certification: three manufacturing site in the U.S., one in Europe, two in the Middle East, and one in China—as well as five downstream user sites in Europe. It is important to acknowledge that by maintaining certification, the participating sites have been driven to enhance their VECAP-related capabilities through the implementation of auditor recommendations using the plan-do-check-act methodology. We continue to believe that increasing the number of use sites certified to meet VECAP requirements is important for the program’s long-term development.
THE VECAP TEAM AND EMISSIONS SURVEY TOOL

VECAP’s success is due to the combined efforts of a team of professionals with knowledge of polymer additive production and application processes. Members of the product stewardship team include a North American representative from each company, European oversight representatives from each company and an independent third party for data management. The product stewardship team develops the tools needed for the methodology, including the questionnaires, which focus on potential emissions from processes and packaging to air, water and land.

Once the user has completed the questionnaire, the VECAP team issues a survey report highlighting potential emissions and recommendations on how best to achieve emission reductions. If these recommendations are implemented, an updated emissions report is issued and sent to the user. Because continuous improvement is critical to the success of this voluntary program, further recommendations are made in some cases.

A full survey of every user is not undertaken each year, as the VECAP team focuses on “new” participants and areas where the greatest emission reductions may be expected, based on analysis of the previous year’s survey.

EMISSIONS DATA COLLECTION & REPORTING

To ensure full compliance with anti-trust regulations, no customer data or volumes are directly shared among the companies that participate in VECAP. Consequently, survey results are consolidated under the oversight of an independent third party. When more than one producer is supplying the same user, the volume supplied is aggregated by the third party data management team. Only the aggregated data is shared among the companies. Data are then assessed to obtain estimated potential emissions in grams of emitted chemical per tonne of chemical handled by the site, reported simply as grams/tonne. The VECAP independent third party is the only entity with access to the confidential potential emissions data of all participants. The consolidated results of the surveys from 2012 are presented in this report.

PROVIDING SUPPORT FOR VECAP USERS

VECAP helps companies implement best practices and make continuous improvements. The VECAP system begins with user commitment to the program, adopting the code of good practice and applying VECAP principles to procedures and work instructions. As an annex to the code, best available technique (BAT) guidance documents have been developed for emptying packaging and intermediate bulk containers (IBC), drums or containers efficiently. These documents are available on the VECAP.info website in multiple languages:
- Key recommendations on good practice for handling polymer additives
- Managing emissions of polymer additives through a proactive implementation of good practices
- Best available technique for emptying bags containing polymer additives brochure
- Poster for best available technique for emptying 20-25kg bags containing polymer additives
- Poster for best available technique for emptying 500-1000 kg bags containing polymer additives

HANDLING AND TREATING CHEMICALS

Below are examples of where and how flame retardant emissions can occur, highlighting critical points in the process of handling and treating chemicals:

**MANUFACTURING**
- Production
- Packaging
- Shipping

**PROCESSING**
- Dust from unloading and feed operations
- Leaks in feed equipment on production lines
- Inadequate or missing air filters
- Improper spill clean-up
- Lack of procedural documentation for product handling

**WASTE DISPOSAL**
- Residues in packaging
- Poorly treated wastewater from system wash-outs
- Waste not reprocessed
- Use of landfills that are not chemically secure
- Unintended emissions, such as that associated with the recycle of waste packaging
FIGURE 2: PROCESS OF HANDLING AND TREATING CHEMICALS

POTENTIAL ENVIRONMENTAL EMISSIONS

WASTE WATER    DUST TO AIR

INPUTS          PRODUCTION PROCESS          OUTPUTS

PROCESS WASTE – POTENTIAL LAND EMISSIONS

DUST FILTER    FLOOR SWEEPING    EMPTY PACKAGING
II. VECAP PROGRESS REPORT 2012

Simply put, VECAP is working. Collectively, the participants have moved beyond awareness and preparation and squarely into a phase marked by significant year-to-year improvement. And as VECAP stewards continue to grow their knowledge base and become even more effective at developing and administering the program, there’s every reason to believe that the positive trends observed in 2012 will persist through next year and beyond.

OVERVIEW OF THE 2012 SURVEY

In 2012, 88% of the total volume of Deca-BDE, HBCD and TBBPA sold by Bromine Science and Environmental Forum (BSEF) member companies (Albemarle, Chemtura and ICL-IP) in 2011 was covered by the survey. Survey participants sign up to the code of good practice and take all necessary steps to reduce levels of potential emissions. Participation in the program increased overall by 28% between 2011 and 2012, primarily due to VECAP stewards’ efforts to gain or regain user participation in the program.

It should be noted that these participation figures relate only to users and volumes supplied by BSEF member companies. While volumes supplied by non-BSEF members are not included, we believe that the handling of products by these users will not be significantly different from volumes supplied by BSEF members, provided they are implementing VECAP practices.

KEY FINDING

Since our last report, we have explored landfill practices in the United States and have concluded that because regulations require U.S. landfills to utilize a liner with leachate control, these sites are chemically secure from a VECAP perspective. Thus, where in past VECAP reports we would have predominantly reported residues in bags as potential emissions because we did not understand the quality of the landfill used, we now realize that these residues are predominantly not emissions to the environment, rather, these are simply controlled process losses. We believe that Canada utilizes similar landfill technology, but have not yet fully verified its landfill specifications.

Despite these findings, we will continue to report materials to landfill because we want to distinguish between landfill use and incineration use in our data set. It is also worth noting that when viewing the data charts there is a lag between learning that all landfills are controlled and in our reporting, where disposal to uncontrolled landfills is still being reported. We expect this lag to diminish by the next report as more of the user survey information is updated to reflect our landfill findings.
DECA-BDE

Decabromodiphenyl ether (Deca-BDE) is a highly effective flame retardant that increases a product’s resistance to ignition and can dramatically increase escape time in the event a fire does occur. It is used to prevent fires in textiles, in the transportation sector (e.g. automotive and aviation industries), in construction and buildings (e.g. wires, cables, pipes), and in electronic devices.

In 2009, the VECAP sponsor companies voluntarily began a four-year schedule to phase out distribution of Deca-BDE in the United States. In 2010, the phase-out was extended to also cover distribution of Deca-BDE in Canada. The phase-out was completed for most uses by the end of 2012, but allowed extension to the end of 2013 for critical use applications.

The phase-out contributed to a dynamic and challenging VECAP environment, as users were understandably focused on evaluating and transitioning to alternate flame retardants. It is postulated that the phase-out of Deca-BDE has contributed to lowering potential emissions for Deca-BDE users as the volume of Deca-BDE in use transitioned from a large number of small-to-large sites to a low number of large sites that predominantly employed highly compliant VECAP practices.
2012 SURVEY RESULTS FOR DECA-BDE

In 2012 the VECAP survey covered 34 out of 61 user sites in North America, which represents 77% of the volume sold in 2011 by BSEF member companies.

For Deca-BDE, total potential emissions reported in 2012 were 491 grams/tonne, which represents 0.05% of the total volume sold to participating companies by BSEF member companies in 2011. In other words, 99.95% of all Deca-BDE handling is controlled, most of which is through formulation into its intended application. Overall, total potential emissions have been reduced by 58% in relation to the 2011 survey for volumes surveyed at VECAP participating companies.

We have also seen an increase in the VECAP participation of Deca-BDE users over the survey year, growing by 40% from 2011 to 2012.

2012 POTENTIAL EMISSIONS TO AIR AND WATER

2012 findings show potential yearly emissions to air to be 157 grams/tonne for volumes surveyed, which represents a 24% decrease compared to 2010 figures. We believe this decrease was due to refinement in the use of best available technique practices.

Potential water emissions increased from 3 grams/tonne to 9 grams/tonne for volumes surveyed. This was due to the handling practices of the specific transitory customer mix supplying survey information for VECAP in 2012.

POTENTIAL EMISSIONS TO LAND AND DESTINATION OF PACKAGING WASTE

2012 data show an 81% reduction in potential land emissions from packaging waste, from 1680 grams/tonne to 325 grams/tonne. This can be attributed to a better understanding of users’ packaging waste disposal practices.

The 2012 survey demonstrated that only 61% of Deca-BDE used packaging material was known to be handled according to best practices such as incineration or disposal in chemically secure landfill sites. In our data collection, we assume the worst when data is unavailable. For example, we had previously assumed that packaging waste was being sent to landfills that are not chemically secure when the users themselves were uncertain of the capabilities of the landfill utilized. However, when the product stewardship team verified the actual capabilities of the landfills used for packaging waste, it became apparent that it was being disposed of according to best practices and that our initial estimates were overstated. Further, since the last report, we have explored landfill practices in the United States and have concluded that regulations governing U.S. landfills render these sites chemically secure (defined within VECAP as having liners and leachate control). So, where in past VECAP reports we would have reported residues in bags as potential emissions because we did not understand the quality of the landfill used, we now realize that these residues are not emissions to the environment; rather, these are simply controlled process losses. We believe that Canada utilizes similar landfill technology, but we have not yet fully verified its landfill specifications.

It is also worth noting that the destination of Deca-BDE packaging has not been fully documented in our surveys, which has led to a lag between our learning that all landfills are controlled and our reporting of uncontrolled landfills emissions. We expect this lag to diminish by the next report as more of the user survey information is updated to reflect our landfill findings. As a result, a significant portion of the packaging disposal (39%) has not been fully documented.
HBCD

Hexabromocyclododecane (HBCD) is a flame retardant used mainly in thermal insulation foams to protect human lives and property from fire. Its main application is in expanded and extruded polystyrene (EPS and XPS) insulation foam boards widely employed by the construction sector. HBCD also has minor application in electrical boxes (high-impact polystyrene) and in the back coating of textiles, mainly for upholstered furniture.

2012 SURVEY RESULTS FOR HBCD

In 2012, the VECAP survey covered 12 out of 27 user sites in North America, which represents 86% of the total volume sold by BSEF members companies in 2011. Participation has increased by 91% in relation to the 2009 survey. This increase can be attributed to a major emphasis on integrating more users into the program in 2011 and 2012 survey years.

For HBCD, total potential emissions reported in 2012 are 392 grams/tonne or 0.04% of the total volume supplied to the market by VECAP participating companies. In other words, 99.96% of all HBCD use is controlled, mostly through use in its intended application. Overall, total potential emissions have been reduced by 5% in relation to the 2011 survey for VECAP participating companies.

2012 POTENTIAL EMISSIONS TO AIR AND WATER

Potential air emissions in 2012 are at 65 grams/tonne for volumes surveyed, which is a 12% decrease over last year’s survey results. It is surmised that this decrease is attributed to the continued use of best practices, as well as an increase in the use of low dust material.

Potential emissions to water in 2012 decreased by 17%, from 6.8 grams/tonne to 5.7 grams/tonne for volumes surveyed.

FIGURE 11: Potential HBCD emissions by emission type (g/t)

POTENTIAL EMISSIONS TO LAND AND DESTINATION OF PACKAGING WASTE

Potential land emissions are at 321 grams/tonne for volumes surveyed, representing a 5% reduction from 2011 data. This reduction can be attributed to a better understanding of users’ disposal of packaging waste. Previous estimates of uncontrolled potential HBCD emissions in packaging waste residues were overstated, as users were unsure of landfill qualifications. So according to VECAP practices, these wastes were considered as worst-case scenarios (sent to unsecured sites) and classified as uncontrolled emissions.

However, when the product stewardship team inquired into the destination of waste, and with our additional research into the capabilities of modern landfills, it became apparent that it was being disposed of according to best practices (chemically secure landfill or incineration).

The 2012 survey shows that 35% of HBCD was known to be handled according to best practices. This figure is expected to increase as users provide further information on the destination of packaging waste and as all surveys are updated with our learnings.
TBBPA

Tetrabromobisphenol-A (TBBPA) is the brominated flame retardant employed mainly in the manufacture of printed wiring boards for use in electrical and electronic equipment. More than 90% of FR-4 printed circuit boards are believed to be produced using TBBPA. For printed wiring boards and other TBBPA applications, these processes are primarily reactive types that chemically transform the TBBPA into a polymer and eliminate the potential for TBBPA to leach from the product.

2012 SURVEY RESULTS FOR TBBPA

The VECAP survey covers 9 out of 19 TBBPA user sites in North America, representing 94% of total volume sold by BSEF member companies in 2011.

For TBBPA, total potential emissions reported in 2012 are 13 grams/tonne for the volume surveyed, which is approximately 0.001% of the total volume sold by BSEF member companies in 2011. Overall, total potential emissions have remained flat compared to the 2011 survey for VECAP participating companies.

Overall there was an 8% increase in VECAP participation by TBBPA users between 2011 and 2012.

2012 POTENTIAL EMISSIONS TO AIR AND WATER

For 2012, potential emissions to air are 13 grams/tonne for volumes surveyed, which show a continued downward trend over 2011 potential emissions. This demonstrates the uptake and continued use of best available technique practices. Potential emissions to water were 0 grams/tonne for volumes surveyed.

POTENTIAL EMISSIONS TO LAND AND DESTINATION OF PACKAGING WASTE

Potential land emissions were found to be less than 1 gram/tonne for volumes surveyed in 2012.

Due to the widespread implementation of VECAP best practices among TBBPA users, when compared to Deca-BDE and HBCD results on a grams/tonne basis, the overall emissions for TBBPA are lower. This is further supported by the high level of packaging waste incineration, a preferred disposal practice by TBBPA users.

Disposal of 100% of packaging waste is now handled using VECAP best practices, such as incineration and chemically secured landfill.

FIGURE 14: Potential TBBPA emissions by emission type (g/t)

FIGURE 15: Survey 2012 (Volume 2011) destination of TBBPA packaging
III. OUR VISION FOR THE FUTURE

Increasing awareness of chemical handling processes will always remain a VECAP objective. As the program evolves, the participants will continue to build on the most recent results and lessons learned to turn awareness into action with measurable results. With the goal of continuous improvement, the VECAP team will work to ensure further progress over the next few years by:

1. Understanding emissions associated with waste packaging

A major accomplishment of VECAP has been to identify the main potential sources of emissions. In the 2012 survey, packaging waste was confirmed as the leading source of potential land emissions. Though we have learned much, further understanding the disposal practices and capabilities of landfills utilized for packaging wastes in all NAFTA countries will be a continuing priority in the coming years.

2. Increasing VECAP coverage

Our industry will continue to promote the use and benefits of VECAP with the goal of increasing program participation. In particular, the VECAP team will seek to not only enhance the participation of our direct customers, but also the participation of second-line users and our distribution networks. We will work to increase the use of VECAP best practices both geographically and through the inclusion of new products.

3. Implementing VECAP best practices where potential emissions have been identified

VECAP aims to promote the implementation of best practices among users who have not yet implemented recommendations to reduce their potential emissions.

4. Encouraging widespread acceptance of VECAP certification

So far, mainly flame retardant manufacturing sites have achieved VECAP certification. It is important for the program to broaden certification acceptance among users, as this represents the ultimate commitment to the program and assurance that the voluntary emissions reduction plan is properly implemented.

ABBREVIATIONS

| BAT       | Best available technique          | HBCD | Hexabromocyclododecane |
| BFR       | Brominated flame retardant         | HIPS | High-impact polystyrene |
| BSEF      | Bromine Science & Environmental Forum | TBBPA | Tetrabromobisphenol-A |
| Deca-BDE  | Decabromodiphenyl ether           | TFA  | Textile Finishers Association (UK) |
| FR        | Flame retardant                   | VECAP | Voluntary Emissions Control Action Program |
FOR FURTHER INFORMATION:

www.vecap.info

VECAP Product Steward:
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Companies that participate in VECAP are also members of the North American Flame Retardants Alliance (NAFRA). NAFRA is made up of leading companies that manufacture or market flame retardants in North America. NAFRA encompasses all types of flame retardants, including those based on bromine, chlorine, phosphorus, nitrogen and inorganic compounds. NAFRA is a sector group of the American Chemistry Council.

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The Bromine Science and Environmental Forum (BSEF) is the international organization of the bromine chemical industry, whose remit is to inform stakeholders and commission science on brominated chemicals such as flame retardants.

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1 Deca-BDE, HBCD and TBBPA refer to decabromodiphenyl ether, hexabromocyclododecane and tetrabromobisphenol A, respectively
2 www.americanchemistry.com
3 Albemarle Corporation, Chemtura Corporation and ICL Industrial Products
4 www.bureauveritas.be
5 For more information, visit: www.vecap.info/europe/userdocumentation