TV REALITY:
Toxic Flame Retardants in TVs

A REPORT BY TOXIC-FREE FUTURE AND CLEAN PRODUCTION ACTION

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Executive Summary

Televisions have historically contained large amounts of flame retardants, which scientists believe has contributed to the presence of toxic flame retardants in the home environment. Makers of televisions don't have to report what chemicals are in their products, so policymakers, scientists, and the public have been in the dark about what flame retardants are currently used in TVs.

We tested 12 television enclosures (the plastic outer portion) for seven types of flame retardants to find out what harmful flame retardants might be hiding in our TVs. Here's what we found:

1. Flame retardants were present in 11 of the 12 TVs, at concentrations of up to 33%, or one-third by weight, in the plastic enclosures.

2. Two televisions contained a banned flame retardant, deca-BDE. Five states have banned use of this compound in TVs, including Washington State, where the televisions were purchased. Some chemical companies producing deca-BDE agreed to phase out U.S. production in 2012, but no federal law or regulation prevents TV manufacturers from using deca-BDE produced in the U.S. or elsewhere.

3. Eight televisions contained flame retardants that are of high concern due to persistence, bioaccumulation, and/or toxicity. These included DBDPE, a close relative of deca-BDE, and 2,4,6-TBP, a hormone-disrupting chemical recently found at surprisingly high levels in placentas.

4. Some manufacturers have avoided using flame retardants of high concern. We detected no flame retardants in one television, and others contained only flame retardants of moderate concern.

These findings are disappointing, with most manufacturers whose products we tested continuing to use flame retardants with health and environmental concerns. On the bright side, a few manufacturers investigated ways to eliminate chemical flame retardants in television enclosures or choose safer, less-toxic flame retardants.

To prevent continued exposure to harmful flame retardants used in televisions, we recommend the following actions:

1. State and local policies should restrict high-concern flame retardants in television enclosures and require manufacturers to identify and adopt safer alternatives.

2. States with laws banning the use of deca-BDE should take immediate enforcement actions to prevent companies from selling televisions containing the banned flame retardant.

3. States should require companies to disclose chemicals of high concern in electronics, including televisions, giving consumers and policymakers information to better understand what chemicals are used in electronics and to take action.

4. Manufacturers should adopt and make public comprehensive corporate chemicals policies to ensure televisions they produce are free of high-concern flame retardants and other high-concern chemicals. Manufacturers making TVs with deca-BDE should use a safer alternative immediately.

5. Retailers should ensure televisions and other electronics they sell are free of high-concern flame retardants and other high-concern chemicals by adopting and making public comprehensive chemicals policies. Retailers selling TVs with deca-BDE should cease to do so immediately.

Introduction

Most people don't think of televisions—a fixture in more than 97% of U.S. homes—as a likely indoor pollution source that could threaten health. But for decades, TV manufacturers have been using toxic flame retardants that leach out into our homes, and new testing shows TV enclosures contain up to one-third toxic flame retardants by weight.

Why is it important to know what flame retardants are in televisions? Since the average U.S. household contains 2.3 TVs, and the exterior plastic parts contain flame retardants, TVs can constitute one of the larger reservoirs of flame retardants in the home.[1-3] Flame retardants are of concern because of their toxicity—many are linked to cancer, harm to the nervous system, hormone disruption, and other health problems—and because often they don't stay in the plastic but leak out into our homes.[4]

Household dust collects the flame retardants that migrate from televisions and other electronic products.[5] Research indicates that flame retardants leave electronics casings when they are abraded during use, and that flame retardants in plastic move directly into dust on the surface of the product.[6] Adults and children are then exposed to flame retardants when they ingest dust, such as through hand-to-mouth activity. Deca-BDE is among the flame retardants found at the highest concentrations in house dust, possibly to a large extent due to its use in televisions.[5,7]

For a long time, we have known that television enclosures, the hard plastic surrounding the TV, consist of 5% or more flame retardants.[3] Deca-BDE dominated this use until about a decade ago, when it was found to be a persistent, bioaccumulative chemical that could damage nervous system

development.[8,9] Deca-BDE was believed to be used in televisions at levels of 10 to 15% by weight.[10]

In 2007, the Washington State Legislature, followed by the Maine Legislature, banned deca-BDE for use in electronics, including televisions.[11,12] The European Union banned its use in electronics in 2008, and Washington's ban went into effect for televisions in 2009. In that same year, two other states passed bans and the U.S. manufacturers of deca-BDE and its largest importer came to an agreement with the U.S. Environmental Protection Agency (EPA) to stop producing and importing the flame retardant for televisions by the end of 2012.

What happened next has been, until now, unclear. Television companies were widely believed to have switched to an almost identical chemical known as decabromodiphenylethane (DBDPE), or to phosphate flame retardants including resorcinol bis (diphenylphosphate) (RDP) and bisphenol A bis (diphenyl phosphate) (BPA-BDPP). But until now, no systematic testing of television enclosures in the U.S. has been conducted to confirm this expected trend, and there are no requirements in the U.S. for disclosure of flame retardants in these housings.

In the U.S., televisions are not required to meet any mandatory fire safety standards. All major manufacturers, however, voluntarily meet standards adopted by UL (formerly known as Underwriters Laboratory, an independent standards development organization). These are based on standards developed by the International Electrotechnical Commission and do not specify that chemical flame retardants must be used. For a snapshot of what flame retardants are now used in television enclosures and at what levels, we tested enclosures from twelve new televisions for flame retardants.

MORE THAN 97% OF U.S. HOMES HAVE AT LEAST ONE TV. THE AVERAGE HOUSEHOLD HAS 2.3 TVS.

Company Policies

Television manufacturers have issued various statements over the years indicating plans or policies related to flame retardant use. To find out where companies now stand, we reviewed the websites of 12 TV manufacturers for their chemicals policies and goals to phase out chemicals of concern (see Table 1). We also evaluated whether they have public policies to reduce toxic chemical use in televisions beyond what laws require.

Our review revealed a disappointing lack of public commitment among television manufacturers to eliminate toxic flame retardants. Six have no statements, four have statements that are vague or don't apply to televisions, and only two demonstrate proactive efforts to avoid chemicals of concern.

Six companies, AOC, Element, Hisense, Samsung, TCL, and Vizio, posted no policy on chemicals in their products. Four companies, Sanyo/Panasonic, Sharp, Sony, and Toshiba, post policies but they lack clarity on their actions to address toxic flame retardants in televisions. For example, Sanyo/Panasonic reported that it was "investigating ways to replace brominated flame retardants where possible," but did not report specific goals or progress.[13] Likewise, Sharp stated that it uses an internal system to evaluate the safety of chemicals, but did not report any reduction goals or progress toward reducing the use of chemicals of concern.[14] Sony stated it has acted voluntarily (i.e. beyond legal requirements) to reduce the use of chemicals of concern in telephones, but reported no action for televisions.[15] Toshiba has set a goal to reduce the use of PVC and brominated flame retardants in products across 66 product groups—but doesn't list those product groups, making it impossible to know whether televisions are included.[16]

Two companies reported proactive efforts to reduce chemicals of concern beyond legal requirements in televisions. LG has banned the entire class of PBDE flame retardants, which includes deca-BDE, in all its products. In addition, Best Buy has taken significant actions to reduce hazardous flame retardants and

announced plans for more reductions. Its private label brand Insignia started a pilot project in 2015, since discontinued, aimed at reducing the need for flame retardants with an engineering solution: removing the power source from the interior of a television model.[17] In August 2017, Best Buy released a chemical management statement stating it seeks to "reduce the use of chemicals, phase out chemicals of concern, and improve the general management of chemicals."[18]

TABLE 1: CORPORATE CHEMICALS POLICIES

Manufacturer	Corporate Chemicals Policy	Television-Specific Chemical
AOC	**Policy:** None identified **RSL:** None identified **Reduction goals/progress report:** None identified	None identified
element	**Policy:** None identified **RSL:** None identified **Reduction goals/progress report:** None identified	None identified
Hisense	**Policy:** None identified **RSL:** None identified **Reduction goals/progress report:** None identified	None identified
INSIGNIA / BEST BUY	**Policy:** Best Buy Chemicals Management Statement[18] **RSL:** Chemical Management Statement states that Best Buy maintains a detailed RSL for private label and direct import products. RSL not publicly available. **Reduction goals/progress report:** None identified	In 2015, began a pilot project, since discontinued, to remove the power source from the interior of the TV, reducing the need for flame retardants.[19]
LG	**Policy:** Corporate Hazardous Substances Management Policy[20] **RSL:** Publicly available, includes ban on PBDEs in all products.[21] **Reduction goals/progress report:** Website indicates that business units have phase out programs, but does not provide details on which chemicals, progress or timelines.[21]	None identified
SAMSUNG	**Policy:** 2016 Sustainabilty Report refers to chemicals management, but not hazard reduction.[22] **RSL:** None identified **Reduction goals/progress report:** None identified	None identified
SANYO / Panasonic	**Policy:** Corporate chemicals policy[23] **RSL:** Green Procurement Guidelines[24] **Reduction goals/progress report:** Investigating ways to replace BFRs where possible. No timeline or progress identified. Initiatives in place for other product types.[25]	None identified
SHARP	**Policy:** Uses internal Chemical-Product Assessment (C-PA) system to evaluate the safety of chemicals.[14] **RSL:** None identified **Reduction goals/progress report:** None identified	None identified
SONY	**Policy:** Corporate Management of Chemical Substances[15] **RSL:** Management Regulations for the Environment-related Substances to be Controlled which are Included in Parts and Materials[26] **Reduction goals/progress report:** Initiatives for other product types[15]	None identified
TCL	**Policy:** None identified **RSL:** None identified **Reduction goals/progress report:** None identified	None identified
TOSHIBA	**Policy:** None identified **RSL:** None identified **Reduction goals/progress report:** Initiatives for other product types[27]	None identified
VIZIO	**Policy:** None identified **RSL:** None identified **Reduction goals/progress report:** None identified	None identified

Methods

Twelve televisions, each of a different brand, were selected for testing with selection criteria designed to reflect the current marketplace. Market reports indicate that approximately half of television sales are from well-known, major manufacturers, and the other half is made up of sales from smaller, less-well-known manufacturers.[28] Televisions were purchased in-store and online from major retailers. Models were selected with the goal of testing some of the most popular models while also selecting a range of sizes and types.

A two-inch diameter piece of plastic from the enclosure of each television was removed and sent to Dr. Heather Stapleton's laboratory at Duke University for flame retardant analysis. Small pieces of the polymer were excised from the surface of the housings using a solvent-cleaned razor blade, accurately weighed, transferred to a 1 L volumetric flask, and extracted with toluene. An initial screening was performed using gas chromatography/mass spectrometry (GC/MS) in full scan using both electron ionization (EI) and electron capture negative chemical ionization (ECNI). Flame retardants were quantified using GC/MS in select ion mode to quantify 2,4,6-tribromophenol (2,4,6-TBP), octabromotrimethylphenylindane (OBIND), deca-BDE, DBDPE, and 2,4,6-tris(2,4,6-tribromphenoxy)-1,3,5-triazine (TTBP-TAZ). Samples were also analyzed using liquid chromatography tandem mass spectrometry (LC/MS/MS) to quantify RBDPP and BPA-BDPP. Table 2 lists flame retardants analyzed, and detailed laboratory methods are in Appendix 1.

Hazards of flame retardants found in the televisions were examined using GreenScreen® for Safer Chemicals and its related tool, GreenScreen List Translator™, a method for chemical hazard assessment developed by Clean Production Action and designed to identify chemicals of high concern and safer alternatives. GreenScreen is a systematic method that allows chemicals to be compared to one another for hazard, including toxicity, persistence, and bioaccumulation. It assigns chemicals to one of four levels based on 18 different hazard endpoints, with an additional Benchmark U for chemicals with insufficient data. The Benchmarks range from Benchmark 1, Chemical of High Concern, to Benchmark 4, Prefer-Safer Chemical. GreenScreen is used by industry, government and NGOs to support product design and development as well as materials procurement, and as part of alternatives assessment to meet regulatory requirements.

Clean Production Action also developed an abbreviated version of the GreenScreen method called the GreenScreen List Translator, which provides a "list of lists" approach to quickly identify chemicals of high concern. It does this by scoring chemicals based on information from more than 40 hazard lists developed by authoritative scientific bodies convened by international, national and state governmental agencies, intergovernmental agencies and NGOs.

TABLE 2: FLAME RETARDANTS OF INTEREST

Chemical Name	Acronym	CAS #	Type
Decabromodiphenyl ether	Deca-BDE	1163-19-5	brominated
Decabromodiphenyl ethane	DBDPE	84852-53-9	brominated
1,3,5-Triazine, 2,4,6-tris(2,4,6-tribromophenoxy)	TTBP-TAZ	25713-60-4	brominated
Octabromotrimethylphenylindane	OBIND	1084889-51-9	brominated
2,4,6-tribromophenol	2,4,6-TBP	118-79-6	brominated
Resorcinol diphosphate	RBDPP	125997-21-9	phosphate
Bisphenol A bis-(diphenylphosphate)	BPA-BDPP	5945-33-5	phosphate

Results

Flame retardants were detected in enclosures—the hard plastic surrounding a TV—from 11 of 12 TVs (see Table 3). We found a wide range of concentrations, from less than 1% all the way up to 33.2%, meaning that up to one-third of the weight of the enclosure actually consists of chemical flame retardants. Table 3 and Figure 1 show detailed results.

Surprisingly, our results reveal that most manufacturers are using a mixture of flame retardants, with the most commonly used being an apparent newcomer: 1,3,5-Triazine, 2,4,6-tris(2,4,6-tribromophenoxy) (TTBP-TAZ). U.S. production of this compound was first reported in 2010, and it was detected in televisions and other electronics in the Netherlands in 2012.[29, 30] TTBP-TAZ was found in 7 of the 12 televisions we tested, at concentrations ranging from 7.67% to 30.7%.

But TTBP-TAZ was generally not used alone. DBDPE was used alongside it in 5 of 7 cases, adding significantly to the total flame retardant concentration in the product.

FIGURE 1: FLAME RETARDANTS FOUND IN TVS

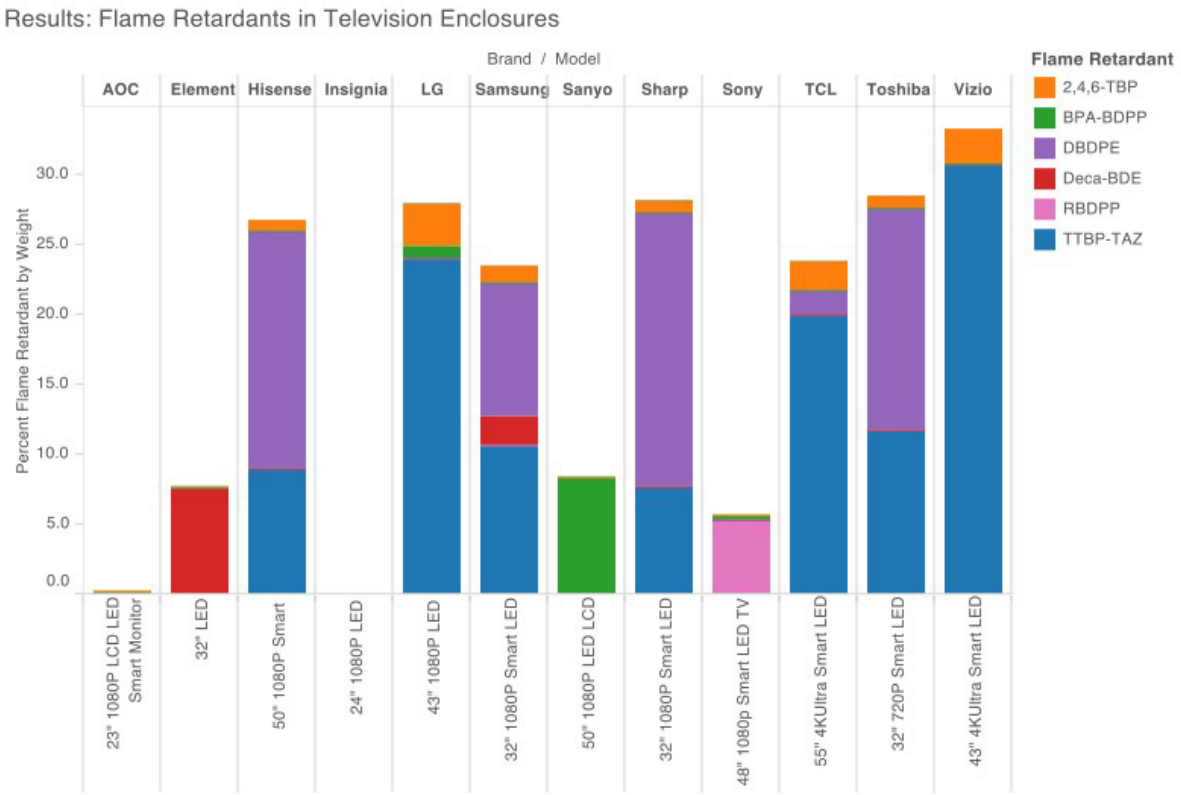


TABLE 3: FLAME RETARDANTS FOUND IN TVS

Brand	Model	Percent of Product Weight						Total Toxic Flame Retardants
		Flame Retardants of High Concern				Flame Retardants of Moderate Concern		
		Deca-BDE	DBDPE	TTBP-TAZ	2,4,6-TBP	BPA-BDPP	RBDPP	
OUT OF COMPLIANCE								
element	32" ELEF328LED HDTV	7.62%	ND	ND	0.079%	ND	ND	7.70%
SAMSUNG	32" Class J525D Full LED Smart TV	2.14%	9.47%	10.6%	1.24%	ND	ND	23.4%
CONTAINS FLAME RETARDANTS OF HIGH CONCERN								
Hisense	50" Class HD Roku TV	ND	16.9%	9.01%	0.800%	ND	ND	26.7%
LG	43" Class 43LH5000 LED TV	ND	ND	24.0%	2.99%	0.887%	ND	27.9%
SHARP	32" Class LED Smart HDTV	ND	19.6%	7.67%	0.819%	ND	ND	28.1%
TCL	55" UP120 4K UHD LED Smart TV	ND	1.70%	20.0%	2.04%	ND	ND	23.7%
TOSHIBA	32" Class LED Chrome-cast HDTV	ND	15.9%	11.7%	0.856%	ND	ND	28.5%
VIZIO	43" Class SmartCast E-Series LED TV	ND	ND	30.7%	2.50%	ND	ND	33.2%
CONTAINS FLAME RETARDANTS OF MODERATE CONCERN, >0.5% OF PRODUCT WEIGHT								
SANYO Panasonic	50" FW50D36F LED LCD HDTV	ND	ND	ND	ND	8.31%	ND	8.31%
SONY	48" 48R510C Bravia Smart LED TV	ND	ND	ND	ND	0.332%	5.29%	5.62%
CONTAINS FLAME RETARDANTS OF MODERATE CONCERN, <0.5% OF PRODUCT WEIGHT								
AOC	23" Frameless LCD/ LED Monitor	ND	ND	ND	ND	0.186%	ND	0.186%
NO DETECTION OF SEVEN FLAME RETARDANTS OF INTEREST								
INSIGNIA BEST BUY	24" LED HDTV	ND	ND	ND	ND	ND	ND	0.00%

TVS WITH BANNED FLAME RETARDANTS

A very concerning finding was the detection of the banned substance deca-BDE in two of the televisions, at concentrations of 2.14% and 7.62%. Sale of televisions in Washington State containing deca-BDE is clearly illegal, with state law banning the sale of televisions or computers with enclosures containing deca-BDE.[11]

Phosphate-based flame retardants, resorcinol diphosphate (RBDPP) and bisphenol A bis-(diphenylphosphate) (BPA-BDPP), were detected in four televisions, in two of those cases at relatively low levels. One television contained none of the seven flame retardants analyzed for.

PROBLEMATIC BREAKDOWN PRODUCT

In every case in which TTBP-TAZ was detected, an impurity and breakdown product associated with the compound was also detected. The chemical 2,4,6-TBP, considered a hormone-disrupting compound, has been found in the flame retardant analytical standard, suggesting it is an impurity.[29,31] In our testing, we found it in the televisions at concentrations ranging from 7% to 12% of the amount of TTBP-TAZ. It has been suggested that 2,4,6-TBP is created in part as the flame retardant/plastic mixture is formed into an enclosure.

Table 4 groups the flame retardants detected in the televisions by hazard score. Four are designated as chemicals of high concern based on full

FLAME RETARDANTS CAN MAKE UP BETWEEN 1% AND 33.2% OF THE WEIGHT OF TV ENCLOSURES. TWO TVS TESTED CONTAINED THE BANNED FLAME RETARDANT DECA-BDE.

Hazards of Flame Retardants

GreenScreen assessments or List Translator™ scores. Two are designated as chemicals of moderate concern based on full GreenScreen assessments.

Four of the analyzed flame retardants have been fully assessed using the Green Screen method. Two brominated flame retardants, DBDPE and TTBP-TAZ, received scores of Benchmark 1 (BM-1), indicating they are chemicals of high concern.[32, 33] Two phosphate flame retardants, RBDPP and BPA-BDPP, received Benchmark 2 scores, indicating they are of moderate concern.[34, 35, 36]

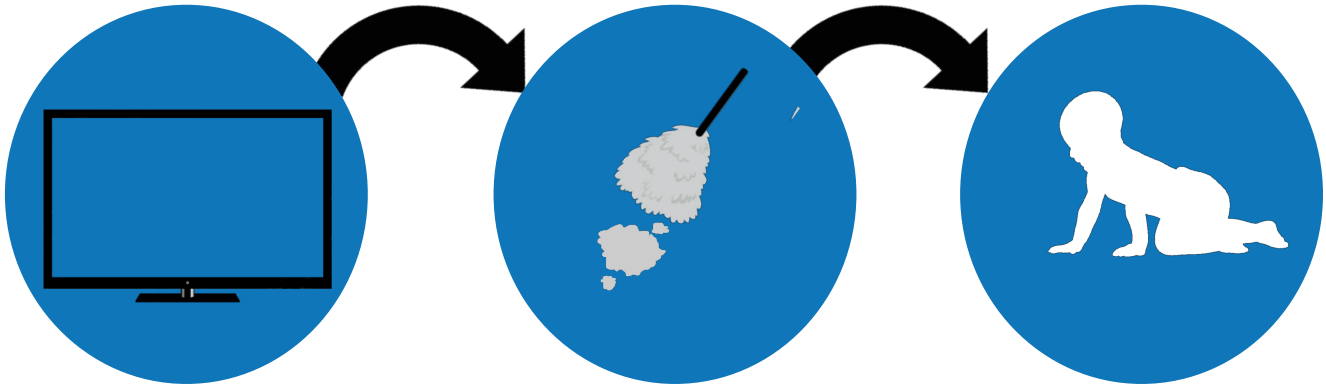
The two chemicals that lack GreenScreen assessments, deca-BDE and 2,4,6-tribromophenol (2,4,6-TBP), have been assessed extensively by government agencies. Both received a List Translator 1 score, meaning their hazard classifications meet one or more of the GreenScreen Benchmark-1 criteria and would most likely be a Benchmark-1 chemical given a full GreenScreen assessment.[37, 38]

TABLE 4: FLAME RETARDANT HAZARDS

Chemical Name & GreenScreen Hazard Score	Primary Hazards	Indoor & Environmental Detections	Notes
GreenScreen Benchmark – 1 / ListTranslator – 1: High Concern			
Decabromodiphenyl ether (Deca-BDE) GS LT-1	• very high persistence • bioaccumulative • effects on nervous system development • suggestive evidence of cancer	Detected in indoor dust, sediment, human serum, sewage sludge, birds, mammals, fish, soil, air	Banned in electronics enclosures in five states
Decabromodiphenyl ethane (DBDPE) GS BM-1	• very high persistence • high neurodevelopmental toxicity (based on similarity to deca-BDE) • hormone disruption	Detected in indoor dust, sediment, human serum, breast milk, sewage sludge, air, sediment	
1,3,5-Triazine, 2,4,6-tris(2,4,6-ribromophenoxy) (TTBP-TAZ) GS BM-1	• very high persistence • very high bioaccumulation • impurity and breakdown product (2,4,6-TBP) is hormone disruptor	Detected in floor and electronics dust	
2,4,6-tribromophenol (2,4,6-TBP) GS LT-1	• very high persistence • bioaccumulative • hormone disruption	Detected in human serum, placenta, indoor dust	Impurity in and breakdown product of TTBP-TAZ
GreenScreen Benchmark 2: Use but Search for Safer Substitutes			
Resorcinol diphosphate (RBDPP) GS BM-2	• very high eco-toxicity • moderate human toxicity • high bioaccumulation	Detected in house, car, furniture, electronics store dust in Europe	
Bisphenol A bis-(diphenylphosphate) (BPA-BDPP)	• high persistence • high bioaccumulation	Detected in house, car, furniture, electronics store dust in Europe	

From TVs to Dust

HOW FLAME RETARDANTS IN TVS CONTAMINATED OUR HOMES



FLAME RETARDANTS CAN ESCAPE THE PLASTIC ENCLOSURES OF TVS INTO HOUSE DUST

HOUSEHOLD DUST CONTAMINATED WITH FLAME RETARDANTS SETTLES IN HOMES, ON FURNITURE, AND FLOORS

PEOPLE, INCLUDING CHILDREN, ARE EXPOSED WHEN THEY INGEST THE DUST SUCH AS DURING HAND TO MOUTH ACTIVITY

A large body of research indicates that flame retardants migrate from electronic products into household dust. Adults and children are then exposed to flame retardants through incidental ingestion of dust, such as through hand-to-mouth activity.

Flame retardants used in electronics have been found at higher concentrations in indoor dust in rooms with electronics. Research in the Boston area found that rooms with more consumer electronics products containing brominated flame retardants had higher levels of deca-BDE in dust, suggesting the electronics were the source.[39] In that study, high levels of the flame retardants in televisions were especially important as a source. A Toronto study found that electronics were the main source in rooms with the highest concentrations of flame retardants in dust.[40] A 2016 study using wipes of electronics found that the flame retardants detected in the wipes at the highest levels were also present in dust at higher levels.[41]

Experiments have shown how flame retardants move directly from electronics to house dust. Researchers conducted chamber experiments attempting to replicate in-home conditions and concluded that flame retardants contaminate dust through abrasion of plastic casings as well as migration directly to dust on the product surface.[6] Scientists have also examined house dust with electronic microscopes and found indications that small particles are abraded from casings to contaminate dust.[42] Finally, analysis of dust collecting in television cabinets detected elevated levels of brominated flame retardants used in television casings as well as in circuit boards.[43]

Regulatory Action

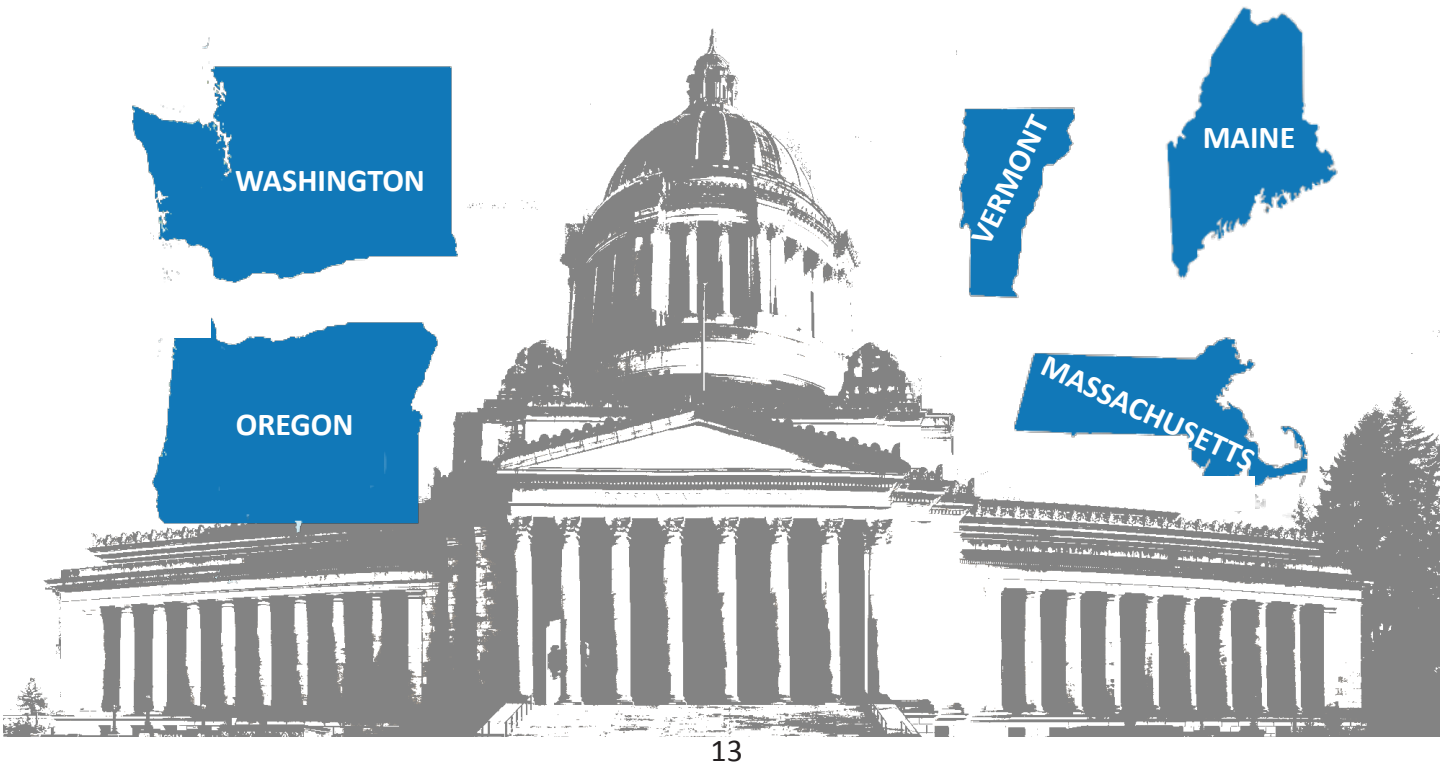
Five states took action between 2007 and 2009 to ban the use of deca-BDE in televisions due to its persistence, bioaccumulation, and effects on nervous system development: Washington, Maine, Oregon, Vermont, and Maryland. In Maine and Washington, the bans were contingent on the availability of safer alternatives. States identified alternatives and the bans went into effect. However, the bans did not include a requirement that manufacturers actually use safer alternatives, leaving open the possibility for companies to choose hazardous replacements for deca-BDE. Maine's 2007 law provided authority for its state environmental agency to ban flame retardants in a number of product categories if a safer alternative has been identified, so this law could be used to avoid substitution with high-concern flame retardants beyond deca-BDE.

The European Union restricted the use of deca-BDE in electronics in 2008 as part of the Restriction of Hazardous Substances (RoHS) Directive.

Several states (Washington, Oregon, and Vermont) also have disclosure laws requiring manufacturers to report on toxic chemicals in children's products, but they exempt electronics; Washington considered a bill in 2017 that would expand reporting to all consumer electronics. Maine and California also have broad authority that can include disclosure requirements but is exercised on a case-by-case basis.

At the federal level in the U.S., where there are no current restrictions on deca-BDE, the USEPA has started the process of taking expedited action under the 2016 chemicals law known as the Lautenberg Chemical Safety Act. In its preliminary document developed under that process, the EPA indicates there is ongoing use of deca-BDE in the U.S., including one producer, two importers, and 23 processors.[44]

FIVE STATES HAVE LAWS BANNING THE SALE OF TELEVISIONS CONTAINING DECA-BDE.



Recommendations

To reduce exposure to toxic flame retardants from their use in televisions, we recommend the following actions:

FEDERAL, STATE, AND LOCAL POLICIES

1. State and local policies should restrict the use of the most hazardous flame retardants in television enclosures and require manufacturers to assess and adopt safer alternatives.
2. The USEPA should initiate rulemaking to end the use, production, and import of deca-BDE in all products as part of its expedited action program under the Lautenberg Chemical Safety Act.
3. States should require companies to disclose chemicals of high concern used in electronics, including televisions, giving consumers and policymakers information to better understand what chemicals are used in electronics and to take action.
4. Procurement policies for televisions should include requirements for disclosure of flame retardants and avoidance of high-concern flame retardants.
5. States with laws banning the use of deca-BDE should take immediate enforcement actions to prevent companies from selling televisions containing the banned flame retardant.

TELEVISION MANUFACTURERS

1. Manufacturers should adopt and make public comprehensive chemicals policies that include restrictions on hazardous flame retardants and clear goals and timelines for phaseouts. They should publicly report each year on progress toward goals and actively work with their supply chains to ensure compliance.
2. Manufacturers should identify safer alternatives and use materials or construction that do not require flame retardants or use least-toxic flame retardants.
3. Manufacturers should report annually to the public on progress toward phasing out hazardous flame retardants, and disclose how electronics are meeting fire-safety standards.
4. Manufacturers should report their chemical management policies and practices to the Chemical Footprint Project Survey, which will enable them to identify opportunities for improvement in chemicals management and measure their progress over time.

TELEVISION RETAILERS

1. Retailers should adopt comprehensive safer chemical policies with RSLs to reduce and eliminate hazardous flame retardants in electronics such as televisions. These policies should include clear goals and timeframes to reduce and eliminate hazardous flame retardants in both private label and brand-name televisions and other electronics.
2. Retailers should develop guidance for suppliers in evaluating the hazards of alternatives to flame retardants of high concern, ensuring safe substitution.
3. Retailers should publicly report on an annual basis on progress in reducing and eliminating hazardous flame retardants in televisions and other electronics.
4. Retails should become signatories to the Chemical Footprint Project (CFP) and encourage their private-label suppliers and brands to participate in the CFP survey.

Appendix 1: Methods for TV Plastic Extraction

Small pieces of the polymer were excised from the surface of the TV housing using a solvent-cleaned razor blade, accurately weighed, and transferred to a 1 L volumetric flask. Toluene was added to the flask to the 1L mark, and the mixture was spun overnight to facilitate complete dissolution. A 1.0 mL aliquot was removed from each extract for an initial screening of flame retardant additives by gas chromatography/mass spectrometry (GC/MS) in full scan using both electron ionization (EI) and electron capture negative chemical ionization (ECNI). Positive identification was made by matching retention times and fragmentation patterns to authentic standards. To quantify the flame retardants in the polymer, a second aliquot (100 µL) was removed from the 1 L solution, internal standards were added, and the extract was diluted to 1.0 mL in hexane. Samples were then analyzed by GC/ECNI-MS in select ion mode to quantify 2,4,6-tribromophenol (2,4,6-TBP), octabromotrimethylphenylindane (OBIND), decabromodiphenyl ether (BDE-209), decabromodiphenyl ethane (DBDPE), and 2,4,6-tris(2,4,6-tribromophenoxy)-1,3,5-triazine (TTBP-TAZ). A five-point calibration was used to quantify flame retardants in the extracts. Three laboratory blanks (toluene only) were analyzed with the samples to monitor background contamination. 13C labeled 2,2',3,4,5,5'-hexachlorodiphenyl ether (13C-CDE141; 50 ng) and 13C-decabromodiphenyl ether (13C-BDE-209; 100 ng) were used as internal standards.

Samples were also analyzed using liquid chromatography tandem mass spectrometry (LC/MS/MS) to quantify resorcinol bis (diphenyl phosphate) (RBDPP) and bisphenol A bis (diphenyl phosphate) (BPA-BDPP). A 1.0 mL aliquot was removed from the original 1 L solution, blow to dryness, and reconstituted in methanol. These samples were spiked with 13C-triphenyl phosphate (13C-TPHP; 100.0 ng) and analyzed using LC/MS/MS using multiple reaction monitoring for RBDPP and BPA-BDPP using the method reported by Ballesteros-Gomez et. al, 2014. Laboratory blanks were also analyzed alongside these samples. A five-point calibration was used to quantify flame retardants in the extracts.

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