HIDDEN HAZARDS

Flame Retardant Chemicals & PFAS in Children's Car Seats

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HEALTHY STUFF

Researching toxic chemicals in everyday products

Contents

Executive Summary

Child car seats are required by law and are absolutely essential for crash safety. Please, always install and use a car seat for a child, regardless of any chemical concerns.

For the Ecology Center's new study on children's car seats, we analyzed flame retardant chemicals in eighteen infant and toddler car seats purchased in 2018. The twelve brands we tested are Baby Trend, Britax, Chicco, Clek, Cosco, Eddie Bauer, Evenflo, Graco, Maxi-Cosi, Nuna, Safety 1st and UPPAbaby. For the first time, in addition to measuring flame retardant chemicals, we tested the seats for fabric treatments likely containing per- and polyfluoroalkyl substances (PFAS).

In addition to this consumer-facing report, Ecology Center researchers have co-authored a peer-reviewed article in the scientific journal Environmental Science and Technology (ES&T) Letters highlighting additional analytical findings from this sample set. The scientific paper validates our testing and reporting of multiple flame retardant chemicals in children's car seats and provides quantified levels.

Over the last decade, our periodic testing and reports have driven major improvements in the use of hazardous chemicals in children's car seats. While our 2018 report shows continued progress and efforts by an increasing number of companies, most seats still contain flame retardants with known hazards or with incomplete hazard profiles, and half were treated with likely PFAS chemicals.

Car seats are unique among children's products because their use is mandated by the government, and they are regulated under automotive fire standards rather than standards for children's products. We continue to advocate for a more appropriate fire standard for car seats to address real-world fire scenarios while avoiding toxic flame retardants.

While our 2018 report shows continued progress and efforts by an increasing number of companies, most seats still contain flame retardants with known hazards or with incomplete hazard profiles, and half were treated with likely PFAS chemicals.

Flame-retardant (FR) chemicals historically used in children's car seats include known mutagens, hormone disruptors, and developmental toxicants. Over the past decade, in part thanks to our work publicly disclosing these additives, children's car seat companies have abandoned toxic FRs such as PBDEs and chlorinated tris and have eliminated lead where it was present in older seats. But the seats still must pass the federal automotive fire standard. According to our testing, replacement chemicals now in use include several phosphorus-based FRs and newer brominated FRs. Some of these, such as triphenyl phosphate, are endocrine disruptors that may contribute to metabolic syndrome. Hazard profiles for several others are incomplete.

Since FRs, with certain exceptions, are not strongly bound to the foams and fabrics to which they are applied, the chemicals migrate out and build up in dust. Children and adults are thereby exposed through breathing and ingesting dust, as well as contact with the skin. Safer alternatives are available, and while our testing has shown trends away from several notorious FR chemicals, companies can still do better.

Our work publicly disclosing these additives in car seats has, over the past decade, led virtually all car seat companies to abandon toxic Flame retardants such as PBDEs and chlorinated tris.

In addition to FR chemicals, we tested for fluorine, likely indicating per- and poly-fluorinated alkyl substances (PFAS), on the children's car seat fabrics. These PFAS are used to impart water- and stain resistance. PFAS have been shown to migrate from fabrics using artificial sweat and abrasion simulations and artificial saliva and mouthing simulations. Once in the body, the chemicals build up in the blood, liver and kidneys and may contribute to diseases of those organs as well as suppression of immune response, elevated cholesterol, thyroid disease, kidney cancer and testicular cancer.

PFAS enter the environment from manufacturing and use, where they travel long distances without breaking down and contaminate soil and water. Because PFAS can easily migrate into drinking water sources, they are now found in drinking water all over the world, including at high levels in water for millions of Americans. We urge car seat companies to stop using PFAS treatments and instead make car seat covers easy to remove and wash.

We believe car seats in the price range of $100-150 or even lower cost can be made without added flame retardants, and we challenge companies to achieve this goal so that healthier seats are more affordable.

Highlights from the 2018 study

Newly launched children's car seats challenge the market

For the first time ever, three manufacturers have answered the call to design and sell car seats free of added FR chemicals. In 2017, UPPAbaby unveiled the first new seat specially designed to contain no added FRs, yet still meet automotive flammability standards. This year, Nuna and Clek launched new models free of added FRs (the Nuna Pipa Lite model and Clek's Mammoth fabric, respectively).

Most child car seats still contain hazardous flame retardants

83% (15 of 18) of seats studied still contain FRs that may be hazardous. Our study shows manufacturers continue to use FRs that present known hazards or are poorly studied. Some of these FRs are the same as those identified in our 2016 study. FRs identified in 2018 include brominated compounds such as decabromodiphenyl ethane and phosphorus-based compounds such as tri(butoxyethyl)phosphate.

For the first time ever, three manufacturers have answered the call to design and sell car seats free of added flame retardant chemicals.

Toxic PBDEs and chlorinated tris are out

Based on the brands we sampled in 2018 and in 2016, companies have replaced these halogenated chemicals in foam with possibly less hazardous phosphorus-based FRs. In fabrics, we found frequent evidence of brominated FRs that may be polymeric and thus may pose less hazard to the user than older classes of FRs, but whose toxicological and environmental profiles are largely unknown.

Half of seats tested contained PFAS

Nine of 18 seats had levels of fluorine at levels suggesting PFAS were intentionally added to the fabric. Nine seats (including the three FR free models) did not. High water and oil repellency are not necessary for car seat fabrics. Designing removable, washable seat covers is a healthier solution.

Design changes can eliminate added flame retardants and PFAS

The newly introduced FR-free car seats include material and design choices, as well as company policies and practices that can be replicated by other companies. All manufacturers of children's car seats should implement such changes to avoid adding FRs and PFAS. We believe car seats in the price range of $100-150 or even lower cost can be made without added FRs and PFAS. We challenge companies to achieve this goal so that healthier seats are more affordable.

The federal government must modify flammability regulations

Children's car seats should either be exempted from the flame standard for vehicles, FMVSS 302, or companies should be allowed to test their products using an appropriate alternative standard. In nearly 40 years of requiring children's car seats to pass FMVSS 302, the government has never evaluated the effectiveness of this rule as it applies to car seats. Nearly a dozen agencies and industry groups queried by consumer reporter Julie Watts in 2016 were unable to provide any data, records, or studies regarding its efficacy, and experts have suggested it is not relevant to real-world fire scenarios in cars. The main impact of the rule appears to be that car seats are treated with hazardous FR chemicals and/ or FR chemicals with unknown toxicological profiles. Alternatively, a few FR-free seats are on the market that use relatively expensive seat designs or materials that are naturally flame retardant. We applaud the companies creating healthier seats. Combined with changes in the federal regulation, such design changes will allow companies to eliminate FR chemicals in all car seats.

In nearly 40 years of requiring child car seats to pass FMVSS 302, the government has never evaluated the effectiveness of this rule as it applies to car seats.

Box 1. Ecology Center researchers co-author peer-reviewed paper in Environmental Science and Technology Letters titled "Children's Car Seats Contain Legacy and Novel Flame Retardants"

In December 2018, the scientific journal Environmental Science and Technology (ES&T) Letters published a peer-reviewed article highlighting analytical findings from our 2018 children's car seat sample set. The paper validates the Ecology Center's 2016 and 2018 reports of a flame retardant (FR) chemical, cyclic phosphonates, that we detected in 2016 and 2018 car seats. The new publication represents the first time this FR chemical has been reported in the scientific literature in North America.

In addition to this novel FR, the new paper also validates several other FR chemicals identified by the Ecology Center's in-house analytical instruments in this year's seats, including decabromodiphenyl ethane, triethyl phosphate, tri(butoxyethyl) phosphate, and triaryl phosphates. To identify those compounds, we conducted HD-XRF and FTIR analyses on over 300 components of 18 children's car seats. We then selected 36 of these samples, including at least one fabric from each seat, for further investigation by mass spectrometry at Indiana University. This allowed us to quantify as well as verify those and more FRs, using certified reference standards.

The novel FR we identified is a mix of two cyclic phosphonates, also known as PMMMPs (5-ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methyl methylphosphonate and bis[(5-ethyl-2-methyl-1,3,2-dioxaphosphorinan-5-yl)methyl] methyl phosphonate p,p;-dioxide). The levels of this FR were quantitatively measured in many of the car seat samples to be an order of magnitude higher than any of the other measured flame retardants, as high as 4% by weight.

The sensitive mass spectrometric analyses also found a surprising variety of legacy FRs at trace levels. In particular, several PBDEs (polybrominated diphenyl ethers, phased out of production in the U.S. by 2013) were measured in 75% of the samples at single-digit or sub-parts per million levels, much too low to indicate intentional use. These included BDE-28, -47, -49, and others. Other brominated FRs found at similar levels were hexabromobenzene and 2,3-dibromopropyl 2,4,6-tribromophenyl ether. Chlorinated tris, TDCIPP, was also measured in 20% of the samples at sub-ppm levels. These low-level detections of legacy FRs reflect the challenge of fully eliminating toxic chemicals from commerce once introduced.

Ecology Center researchers are co-authors on the new publication along with principal investigator Dr. Marta Venier, Yan Wu and Kevin Romanak of Indiana University School of Public and Environmental Affairs, and Viorica Lopez-Avila of Agilent Technologies. Several different mass spectroscopic techniques were used. Detailed description of the instrumental analyses can be found in the article. [12]

Introduction

Children's car seats are required by law and are absolutely essential for crash safety. Please, always install and use a car seat for a child, regardless of any chemical concerns.

The Ecology Center has been testing children's car seats for hazardous chemicals periodically since 2006. In our new study, we present results from testing for an extensive list of flame retardant chemicals and, for the first time, a fluorine analysis that reveals fabric treatments likely based on per- and polyfluorinated alkyl substances (PFAS).

Why flame retardant chemicals are used in children's car seats

Children's car seats are required by federal law to meet flammability standards created for car interiors. Regulation FMVSS 302: Flammability of Interior Materials was written in 1971 with the intent to protect vehicle occupants from fires, particularly fires caused by cigarettes. The U.S. agency responsible for traffic safety, National Highway Traffic Safety Administration (NHTSA), wrote FMVSS 302 and has not significantly changed the rule since it was written.

FMVSS 302 does not require the use of chemical flame retardants but chemical flame retardants have been marketed by the chemical industry as an easy, low cost way for manufacturers to comply with FMVSS 302. Thus, automakers began using flame retardant chemicals to treat interior vehicle parts, such as seat cushions, seat belts, floor coverings, and padding. In 1981, children's car seats were required to comply with FMVSS 302. As a result, children's car seat manufacturers also began to treat the foams and fabrics of car seats.

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What's wrong with having a fire safety standard?

While FMVSS 302 was intended to reduce deaths and injuries from vehicle fires (particularly from cigarettes, which constitute an ever-diminishing share of vehicle fire sources), it has not been shown to have a safety benefit for children in car seats. NHTSA has never evaluated the effectiveness of the rule as it applies to car seats due to lack of relevant data.[1] Nearly a dozen agencies and industry groups queried by consumer reporter Julie Watts in 2016 were unable to provide any data, records, or studies regarding the rule's efficacy, and experts have suggested it is not relevant to real-world fire scenarios in cars. FMVSS 302 has resulted in car seat makers adding thousands of pounds of chemical flame retardants to products that infants and children are in close contact with every day.

Flame retardants pose exposure and health risks

Most flame retardant chemicals used in products like car seats are not strongly bound to the fabric or foam to which they are added, so they easily migrate out and building up in air and dust. Human exposure can occur by breathing, through skin, or by ingesting dust, such as through hand-to-mouth contact.

A number of FRs are known endocrine disruptors and some are linked to cancer. Other FRs are lacking in toxicity information. Many FRs contain chlorine or bromine (these are called halogenated FRs because chlorine and bromine are halogens) and don't break down easily and travel long distances in the environment. Chemical persistence can lead to bioaccumulation, the buildup of a substance in people and animals.

Although the historically-used brominated FR chemicals called PBDEs have been phased out due to health concerns, we continue to find bromine in a large portion of children's car seats. Decabromodiphenyl ethane, or DBDPE, for example, is common in vehicle interiors and was found in this year's study of children's car seats.[2]

Most flame retardant chemicals used in products like car seats are not strongly bound to the fabric or foam to which they are added, so they easily migrate out and become airborne via dust.

DBDPE is expected to be highly persistent and bioaccumulative and exhibits developmental and other types of toxicity. (See Table A, Appendix.)[3,4]

Phosphorus-based FRs (PFRs) can be made without any halogens and have increased in popularity as health and environmental concerns about halogenated FRs have grown. Triphenyl phosphate (TPHP) is one example of a widespread PFR that is used in some children's car seats. While eliminated from the body more quickly than other FRs, TPHP is nevertheless found extensively in the environment and accumulates in breast tissues.[5] It exhibits hormonal and developmental toxicity.[6–8]

Fluorinated "forever chemicals" pose exposure and health risks

For the first time in the Ecology Center's series of car seat studies, we are reporting the likely use of per- and poly-fluorinated alkyl substances (PFAS) on the fabrics of children's car seats.

PFAS encompass a class of chemicals used, among other applications, to make fabrics water- and stain-resistant. Fluorine is a halogen, so PFAS are halogenated chemicals. Even more so than brominated FRs, PFAS are highly stable and don't break down easily. In fact, the incredibly strong carbon-fluorine bond gives some PFAS chemicals their reputation as "forever chemicals."

For the first time in the Ecology Center's series of car seat studies, we are reporting the use of per- and poly-fluorinated alkyl substances (PFAS) on the fabrics of children's car seats.

When PFAS chemicals enter the human body—and virtually every human tested has PFAS in their blood—the chemicals build up in the liver and kidneys and may contribute to elevated cholesterol, suppression of immune response, thyroid disease, kidney cancer and testicular cancer.[9]

The original processing chemicals (called C8 or "long-chain" PFAS) used for Teflon™ cookware coatings and Scotchgard™ fabric treatments have been phased out in the U.S. Yet new, closely related substances have taken their place. The newer PFAS processing chemicals for nonstick and stain-proofing are called C6 (or "short-chain"). C6 chemicals are marketed as safe because they don't build up in the body as efficiently as C8, but new research suggests C6 may nevertheless present a significant health risk.

PFAS in fabrics can easily enter the body through the skin and inhalation. Are children exposed to a significant amount of PFAS from a car seat? The answer is still uncertain. But, a recent study by the Commission for Environmental Cooperation (CEC),[10] a collaboration of the three North American countries, sheds some light. The study detected PFAS in all waterproof baby mats, pads, and blankets tested and nearly half of bibs tested. The researchers used artificial saliva and mouthing simulations as well as artificial sweat and abrasion simulations to test the migration of PFAS. The Commission found that nearly one half of PFAS present in bibs and other children's items transferred in the saliva simulation, and one-fifth transferred in the sweat simulation.[8]

A particularly worrisome finding from the CEC study was that the newer-generation C6 PFAS chemicals more readily migrated into sweat and saliva than the original C8 chemicals.

While infant and child exposure to PFAS from car seat use is the most apparent concern, the manufacturing and disposal— landfilling or incineration— of the chemicals are highly problematic.

While infant and child exposure to PFAS from car seat use is the most apparent concern, the manufacturing and disposal— landfilling or incineration— of the chemicals are highly problematic. The entire lifecycle of PFAS releases chemicals of concern into our water and air.

Chemicals added to products must undergo toxicological assessment

Chemical hazard assessments should be completed on all FRs and other additives prior to their use in products. One option is Clean Production Action's GreenScreen® For Safer Chemicals. This tool uses authoritative lists and trained assessors to determine the hazard profile of a substance. GreenScreen assessments for each of the major FRs found in 2018 and 2016 children's car seats tested by the Ecology Center are given in the Appendix.

2018 Car Seats in the Study

Eighteen seat models representing twelve brands were purchased at retail stores, ordered online, or obtained from the manufacturer in early 2018. The seats, listed in **Table 1**, were manufactured between January 2017 and February 2018.

Table 1. Car seats tested in 2018

Brand	Model	Color	Type	Date of Manufacture	Retail Price	Source
Baby Trend	EZ Flex-Loc	Morning Mist	infant	11/20/2017	$100	Babies R Us, CA
Britax	Advocate ClickTight ARB	Circa	convertible	1/8/2018	$329	Donated by manufacturer
Britax	Roundabout G4.1	Luna	convertible	1/19/2017	$190	Buy Buy Baby, MI
Chicco	KeyFit 30	Regatta	infant	10/1/2017	$200	Babies R Us, PA
Clek	Fllo	Mammoth	convertible	1/18/2018	$430	Donated by manufacturer
Clek	Foonf	Thunder	convertible	2/26/2018	$470	Donated by manufacturer
Cosco	Scenera NEXT	Moon Mist	convertible	1/17/2018	$35	Walmart, MA
Eddie Bauer	XRS 65	Viewpoint	convertible	8/24/2017	$100	Amazon
Evenflo	Nurture	Blake	infant	1/11/2018	$60	Walmart, MI
Evenflo	SureRide DLX	Paxton	convertible	1/11/2018	$100	Costco, MI
Graco	Contender 65	Piedmont	convertible	7/24/2017	$110	Target, MN
Graco	SnugRide	Kyte	infant	1/9/2018	$90	Macy's, MI
Maxi-Cosi	Mico 30	Bright Rose	infant	4/6/2017	$200	Walmart, MI
Nuna	Pipa Lite	Fog	infant	7/19/2017	$350	Modern Natural Baby, MI
Nuna	Pipa	Graphite	infant	4/15/2017	$300	Modern Natural Baby, MI
Safety 1st	Grow and Go 3-in-1	Shadow	convertible	11/16/2017	$170	Babies R Us, NY
UPPAbaby	MESA	Jordan	infant	11/3/2017	$350	Donated by manufacturer
UPPAbaby	MESA	Taylor	infant	10/15/2017	$300	Donated by manufacturer

Test Methods

Each seat was cut apart to isolate materials. Then each component was analyzed by X-Ray Fluorescence spectroscopy (XRF) to measure elemental composition. XRF allows us to screen for likely flame retardant chemicals by detecting chlorine, bromine and phosphorus. A subset of the samples were tested two or more times to verify repeatability. Most fabrics and foams from the car seats were further analyzed by Fourier transform infrared spectroscopy (FTIR) to identify certain flame retardants, if present. Next, a subset of 36 fabric and foam samples, at least one from each car seat, was selected for a sensitive mass spectrometric analysis at Indiana University. Gas or liquid chromatography coupled with mass spectrometry allowed the measurement of 82 flame retardant chemicals in these samples. Finally, fabric samples from each seat were analyzed at Notre Dame University for total fluorine content to reveal PFAS treatments. Further details of these analytical methods are provided on our website healthystuff.org.

Children's car seat with samples of fabrics, foam, and plastic removed and labeled.

Student intern Katherine Kistler using the FTIR.

Findings

Newly launched flame retardant-free seats challenge the market

For the first time, three manufacturers have answered the call to offer car seats free of added FR chemicals. In 2017, UPPAbaby unveiled the first child car seat specially designed to contain no added FRs, yet still meet automotive flammability standards. This year, Clek and Nuna launched new models free of added FRs. All three companies currently offer limited FR-free options among their car seats.

Two "fashions" in UPPAbaby's MESA line of infant seats, the Henry and the Jordan, use a wool-polyester blend seat fabric to meet the flame standard without chemical FRs. Clek offers its new Mammoth fabric, available on Fllo or Foonf models (as well as their Oobr booster and recently released Liing infant seat), made of wool. Nuna's Pipa Lite infant seat uses polyester fabric that is free of added FRs. For the rigid foam components, all three brands' FR-free seats use expanded polypropylene foam without FRs instead of expanded polystyrene foam with brominated FR.

With the exception of the three flame retardant-free seats, manufacturers continue to use flame retardants that present known hazards or are poorly studied.

In addition, UPPAbaby's MESA Henry and MESA Jordan, Clek's Mammoth fabric, and the Nuna Pipa Lite are free of PFAS-based stain resistant coatings, which our testing confirmed.

Most children's car seats still contain hazardous flame retardants

With the exception of the three FR-free seats, manufacturers continue to use FRs that present known hazards or are poorly studied. Some of these FRs are the same as those identified in our 2016 study. FRs identified in 2018 at levels indicating they were likely intentionally added include decabromodiphenyl ethane, triphenyl phosphate, resorcinol bis(diphenyl phosphate), tri(butoxyethyl)phosphate, triethyl phosphate, tris(2,4-di-t-butylphenyl) phosphite, tris(2-ethylhexyl) phosphate, and cyclic phosphonates. Additional brominated flame retardants are very likely present in several of the seat fabrics, but we weren't able to determine molecular composition for FRs in some of the samples in this study. Instead, for some samples we used bromine measured by XRF as a proxy for brominated FRs.[11] Brominated FRs tentatively identified in 2016 seats that weren't analyzed in the 2018 study include brominated polystyrenes and tris(2,3-dibromopropyl) isocyanurate.[11]

Toxic PBDEs and chlorinated tris are out

Based on the brands we sampled in 2018 and in 2016, companies have replaced toxic halogenated chemicals in polyurethane foam with phosphorus-based FRs, some of which may present hazards to health. In fabrics, we found frequent evidence of brominated FRs through XRF detection of bromine. Some of these brominated FRs may be polymeric and thus may pose less hazard to the user than older classes of FRs, but their toxicological and environmental profiles are largely unknown.

Half of seats tested contained likely PFAS

Nine of 18 seats contained fluorinated chemicals—most likely PFAS—at levels indicating they were intentionally added to the fabric. Nine seats (including the three FR free models) did not contain fluorinated chemicals. High water and oil repellency are not necessary for car seat fabrics. Designing removable, washable seat covers is a healthier solution. Alternatively, stain treatments containing no PFAS are increasingly available.

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Design changes can eliminate added flame retardants and PFAS

The newly introduced FR-free car seats include material and design choices, as well as company policies and practices that can be replicated by other companies. All manufacturers of children's car seats should implement such changes to avoid adding FRs and PFAS. We believe car seats in the price range of $100-150 or even lower cost can be made without added FRs and PFAS. We challenge companies to achieve this goal so that healthier seats are more affordable.

Federal government must change flame retardant regulations

Children's car seats should either be exempted from the flame standard for vehicles, FMVSS 302, or companies should be allowed to test their products using an appropriate alternative standard. As noted earlier, in nearly 40 years of requiring child car seats to pass FMVSS 302, the government has never evaluated the effectiveness of this rule as it applies to car seats and have not provided any data, records, or studies regarding its efficacy. Experts have suggested it is not relevant to real-world fire scenarios in cars.[11] The main impact of the rule appears to be children's car seats treated with flame retardant chemicals or, in recent years, made using more expensive seat designs and materials that are inherently flame retardant. We applaud the companies creating healthier seats. Combined with changes in the federal regulation, such design changes will allow companies to eliminate FR chemicals in all car seats.

Table 2. 2018 rankings based on intentionally added flame retardant usage.

Seats are listed in alphabetical order within each ranking category.

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2018 Children's Car Seat Chemical Hazard Ratings

LOW CONCERN

Clek - Fllo - Convertible - Mammoth*

Nuna - Pipa Lite - Infant - Fog

UPPAbaby - MESA - Infant - Jordan

MODERATE CONCERN

Britax - Advocate ClickTight ARB- Convertible - Circa

F **Britax** - Roundabout G4.1- Convertible - Luna

F **Clek** - Foonf - Convertible - Thunder*

Cosco - Scenera NEXT - Convertible - Moon Mist

F **Maxi-Cosi** - Mico 30 - Infant - Bright Rose

Safety 1st - Grow and Go 3-in-1 - Convertible - Shadow

UPPAbaby MESA - Infant - Taylor

*Chemical flame retardant-free Mammoth fabric available on both Clek's Foonf and Fllo, as well as Oobr booster (not tested) and Liing infant seat (not tested).

HIGH CONCERN

F **Baby Trend** - EZ Flex-Loc - Infant - Morning Mist

F **Chicco** - KeyFit 30 - Infant - Regatta

Eddie Bauer - XRS 65 - Convertible - Viewpoint

F **Evenflo** - Nurture - Infant - Blake

F **Evenflo** - SureRide DLX - Convertible - Paxton

Graco - Contender 65 - Convertible - Piedmont

F **Graco** - SnugRide Click Connect 30 - Infant - Kyte

F **Nuna** - Pipa - Infant - Graphite

Ratings are based on the exact model and fabric color tested.
Low: No flame retardants or fluorinated chemicals.
Moderate: Phosphorus-based flame retardants and up to one component with bromine.
High: Phosphorus-based flame retardants and bromine in at least two components.

F Contains fluorinated substances

View complete 2018 Children's Car Seat Report at **healthystuff.org**

Box 2. Recent and upcoming child car seat innovations

Our current study sampled seats sold in 2018 that were manufactured in 2017 and 2018. While we were analyzing these seats, companies continued to innovate, finding new ways to comply with flammability standards without adding flame retardant chemicals. New product features discussed below are based on direct communication with and marketing claims by companies. Healthy Stuff has not fully tested the products below to verify claims.

Clek

Clek's FR-free and PFAS-free wool Mammoth fabric--currently available on the Foonf convertible, Fllo convertible (which we tested), and the Oobr booster--will expand to its new infant seat, the Liing. Liing seats have wool canopies as well as seat covers. Consumers can pre-order them now for a February 2019 delivery. With this development, Clek will have FR-free options for every age.

At present, Clek's non-wool seat covers are treated with PFAS for stain- and water resistance, but that is about to change. In 2019, Clek will transition these fabrics to a GREENGUARD Gold certified, fluorine-free treatment that will still protect the seat fabric against stains.

Britax

Just as Clek's Mammoth fabric is available on multiple seat designs, Britax has introduced SafeWash™ fabric for its Otto fashion, available on three seats, covering all stages of growth: Endeavours infant seat, Advocate ClickTight convertible, and Pinnacle ClickTight harness-2-booster. The SafeWash™ fabric (available for delivery in mid December 2018) is removable and washable, a design feature that allows families to keep seat covers clean without stain-resistant PFAS chemicals.

Dorel (parent company of Cosco, Safety 1st, and Maxi-Cosi)

Dorel is developing a car seat without flame retardant chemicals.

Legacy flame retardant chemicals found at very low levels

The presence of low levels of flame retardants that are no longer in use highlights the difficulty of fully removing legacy toxic chemicals from consumer products and our environment.

As detailed in the paper we co-authored published December 2018 in the peer-reviewed journal Environmental Science and Technology (ES&T) Letters,[12] mass spectroscopic analyses detected multiple flame retardants at low levels— low parts per million or sub-parts per million—in a number of fabrics and soft foams. These compounds included FRs no longer used in car seats such as chlorinated tris (TDCIPP) and polybrominated diphenyl ethers (PBDEs) that are considered legacy flame retardants. In this report, we list only FRs measured at higher than 100 mg/kg (100 parts per million). This threshold was chosen to keep the focus of this report on intentionally added FRs. FR chemicals measured in car seat components at levels lower than 100 ppm are unlikely to be intentionally added. The presence of low levels of FRs no longer in use highlights the difficulty of fully removing toxic legacy chemicals from consumer products and our environment.

How did models from previous years fare in 2018?

Several car seats we tested this year were updated models of the same seats from 2016, and one from 2014. We examined how each changed.

- Chicco Key Fit 30 test results were slightly worse compared to 2016. The 2018 model had likely bromine FRs in fabrics; the 2016 model did not. Both years had brominated FRs in the warning label. Expanded polystyrene foam was used in both.
- Evenflo Nurture test results worsened in 2018. Likely brominated FRs were detected in fabrics in 2018, but not 2016. Additionally, the 2018 model contained known toxic FRs TPHP and RDP that were not detected in 2016.
- Cosco Scenera NEXT did not change significantly. In models from 2016 and 2018, likely brominated FRs were detected in the fabrics; phosphorus-based FRs were detected in fabrics and foam.
- Nuna Pipa did not change significantly. Likely brominated FRs were detected in fabrics, rigid foam, PU foam, and warning labels. The phosphorus-based FR TBEP was detected in foam; cyclic phosphonates were detected in fabrics.
- Clek Foonf with Thunder fabric improved its warning label. In 2016 the warning label contained a high level of bromine; in 2018 the label did not have detectable bromine. In both years' models, the PU foam contained an unidentified phosphorus-based compound.
- Safety 1st Grow and Go 3-in-1 did not change significantly. In both 2016 and 2018, likely brominated FRs were detected in fabrics. Phosphorus-based FRs (TBEP, TEP, and cyclic phosphonates) were detected in PU foams and fabrics.
- Eddie Bauer XRS 65 was last tested in 2014, not 2016. In both 2014 and 2018, this seat was found to have a likely brominated FR in the polyurethane foam. The seat cover in both years includes faux leather made of vinyl (PVC) plasticized with dioctyl terephthalate, a non-phthalate plasticizer.

Table 3 summarizes test results for each seat in the 2018 study. Seat components include fabrics of all types, foams of all types, hard plastic such as frames and buckles, and warning labels. Detailed numerical test results for the car seat components can be downloaded as an Excel file at ecocenter.org/healthy-stuff/pages/car-seats-2018-report.

Table 3. Summarized test results for each seat

Seat components include fabrics of all types, foams of all types, hard plastic such as frames and buckles, and warning labels. See downloadable full results tables at ecocenter.org/healthy-stuff/pages/car-seats-2018-report.

	Number of seat components with detected chemicals				
Seat name (Total number of components tested)	**Decabromo-diphenyl ethane (DBDPE)**	**Other brominated compound**	**Cyclic phosphonate (PMMMPs)**	**Other phosphorus compound**	**Fluorinated compound on fabric**
Baby Trend - EZ Flex-Loc - Morning Mist (14)	0	4	3	0	yes
Britax - Advocate ClickTight ARB - Circa (16)	0	0	0	1	no
Britax - Roundabout G4.1 - Luna (15)	0	0	0	2	yes
Chicco - KeyFit 30 - Regatta (18)	0	4	6	1	yes
Clek - Fllo - Mammoth (11)	0	0	0	0	no
Clek - Foonf - Thunder (13)	0	0	0	2	yes
Cosco - Scenera NEXT - Moon Mist (9)	0	1	0	3	no
Eddie Bauer - XRS 65 - Viewpoint (17)	1	3	2	3	no
Evenflo - Nurture - Blake (16)	1	4	0	4	yes
Evenflo - SureRide DLX - Paxton (18)	0	4	2	6	yes
Graco - Contender 65 - Piedmont (19)	1	2	6	2	no
Graco - SnugRide Click Connect 30 - Kyte (15)	1	1	5	0	yes
Maxi-Cosi - Mico 30 - Bright Rose (18)	0	1	1	2	yes
Nuna - Pipa Lite - Fog (18)	0	0	0	0	no
Nuna - Pipa - Graphite (31)	1	5	8	1	yes
Safety 1st - Grow and Go 3-in-1 - Shadow (20)	0	1	0	5	no
UPPAbaby - MESA - Jordan (14)	0	0	0	0	no
UPPAbaby - MESA - Taylor (19)	0	0	2	0	no

Trends over time

Table 4 examines how car seat upholstery—which includes fabric, soft foam, and fabric laminated to foam—has changed since our 2009 study. Based on XRF measurement of bromine as an indicator of brominated FRs,[11] the table shows that brominated FRs have become less common in upholstery overall. This is because companies have largely stopped using brominated FRs in soft foam. However, our current study shows that *fabrics* in car seats frequently contain likely brominated FRs (see full data tables at healthystuff.org). Based on XRF measurement of chlorine as a likely indicator of chlorinated FRs, Table 4 also shows that chlorinated FRs have been virtually eliminated after our 2014 study. Phosphorus-based FRs may have increased; data is limited.

Table 4. Flame retardant markers in upholstery over time: XRF measurement of bromine, chlorine and phosphorus

	Upholstery samples with likely:		
Year (Number of car seats tested)	**Brominated FRs**	**Chlorinated FRs**	**Phosphorus-based FRs**
2009 (55)	33%	not tested	not tested
2013 (18)	20%	23%	not tested
2014 (16)	11%	19%	not tested
2016 (15)	19%	1%	22%
2018 (18)	16%	1%	42%

Table 5 tracks the measurement of bromine in rigid foam—the type that looks like Styrofoam—in our car seat studies dating back to 2006. Historically, car seat companies have used expanded polystyrene, a material that is hard to recycle and that requires brominated FRs to pass the flame standard. In recent years, several car seat makers have chosen a healthier alternative such as expanded polypropylene foam. This year, some car seats contained a rigid foam made of a third material, polystyrene mixed with polyethylene, and those rigid foam samples contained no bromine. Overall, based on XRF measurement of bromine as an indicator of brominated FRs, the table shows brominated FR usage has significantly decreased in rigid foams since 2006.

Table 5. Brominated FRs in rigid foams of car seats over time

Year (number of car seats tested)	**Rigid foam samples with likely brominated FR**
2006 (131)	77%
2009 (55)	not tested
2013 (18)	62%
2014 (16)	35%
2016 (15)	40%
2018 (18)	32%

Call to Action

We challenge children's car seat manufacturers to design and sell seats in the price range of $100-150 or even lower cost without added flame retardant chemicals so that healthier seats are more affordable.

We call on car seat companies that haven't already done so to eliminate halogens from their seat construction: No brominated or chlorinated FRs, no vinyl (PVC plastic), and no PFAS.

We call on car seat companies to seek out comprehensive toxicological assessments for all chemical additives they use in their products and to choose additives with the lowest possible hazard level.

We call on NHTSA to exempt child car seats from the automotive standard FMVSS 302 or apply a more appropriate flame standard to these children's products.

Go to our website to sign the petition at healthystuff.org.

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Find this document online at www.healthystuff.org

ecocenter.org/healthy-stuff/pages/car-seats-2018-report

Appendix

Table A: Flame Retardant Chemicals found in 2016 and/or 2018 Children's Car Seats: GreenScreen® Assessment of Human and Environmental Hazards

GreenScreen evaluates the hazards inherent in a chemical. It does not evaluate hazards presented by a material or product made with the chemical.

Brominated Flame Retardants

Chemical Name, CAS number	GreenScreen Assessment Score	Human Hazards	Environmental Hazards
Brominated polystyrene **88497-56-7**	Likely Benchmark 1 Avoid	• High endocrine activity	• Very high persistence, bioaccumulation, and toxicity
DBDPE: Decabromodiphenyl ethane **84852-53-9**	Benchmark 1 Avoid	• High developmental toxicity • High endocrine activity • Moderate carcinogenicity • Moderate reproductive toxicity	• Very high persistence, bioaccumulation, toxicity
HBCD: Hexabromocyclodecane **25495-98-1**	Likely Benchmark 1 Avoid	• High reproductive toxicity • High developmental toxicity • High endocrine activity	• Very high persistence, bioaccumulation, and toxicity • High chronic aquatic toxicity
TBBPA: Tetrabromobisphenol A **79-94-7**	Likely Benchmark 1 Avoid	• High reproductive toxicity • High endocrine activity • High carcinogenicity • Moderate developmental toxicity • Moderate eye irritation/corrosivity • Moderate acute mammalian toxicity	• Very high acute and chronic aquatic toxicity • Very high persistence, bioaccumulation, and toxicity
TBC: Tris(2,3-dibromopropyl isocyanurate **126-72-7**	Likely Benchmark 1 Avoid	• High carcinogenicity • High endocrine activity • Moderate mutagenicity • Moderate reproductive toxicity • Moderate acute mammalian toxicity • Moderate systemic toxicity from repeated exposure	• Very high acute aquatic toxicity • Very high persistence, bioaccumulation, and toxicity

(Table A cont.)

Phosphorus Flame Retardants

Chemical Name, CAS no.	GreenScreen Assessment Score	Human Hazards	Environmental Hazards
Ammonium polyphosphate 68333-79-9	Benchmark 3 Use but still opportunity for improvement	• Moderate skin irritation/corrosivity	• Very high persistence
PMMMPs: Cyclic phosphonates 41203-81-0, 42595-45-9	Benchmark unknown	• Unknown	• Unknown
RDP: Resorcinol bis(diphenyl phosphate) 125997-21-9	Benchmark 2 Use but search for safer substitutes	• Moderate developmental toxicity • Moderate endocrine activity • Moderate neurotoxicity- repeated exposure • Moderate eye irritation/corrosivity	• Very high acute and chronic aquatic toxicity • High bioaccumulation • Moderate persistence
TBEP: Tris(2-butoxyethyl) phosphate 78-51-3	Possible Benchmark 1 Avoid	• High endocrine activity • High skin sensitization	• Very high persistence
TEHP: Tris(2-ethylhexyl) phosphate 78-42-2	Possible Benchmark 1 Avoid	• High to moderate endocrine activity • High eye and skin irritation/corrosivity	• Very high acute aquatic toxicity • High persistence
TEP: Triethyl phosphate 78-40-0	Benchmark unknown	• High systemic toxicity • High eye irritation/corrosivity • Moderate reproductive toxicity • Moderate acute mammalian toxicity	• Very high persistence • Moderate terrestrial ecotoxicity
TPHP: Triphenyl phosphate 115-86-6	Benchmark 2 Use but search for safer substitutes	• High endocrine activity • Moderate acute mammalian toxicity • Moderate carcinogenicity • Moderate endocrine activity • Moderate systemic toxicity from repeated exposure • Moderate neurotoxicity from single exposure • Moderate eye irritation/corrosivity	• Very high acute and chronic aquatic toxicity • Moderate terrestrial ecotoxicity

(Table A cont.)

Other Flame Retardants

Chemical Name, CAS no.	GreenScreen Assessment Score	Human Hazards	Environmental Hazards
Antimony Trioxide **1309-64-4**	Benchmark 1 Avoid	• High systemic repeat dose toxicity/organ effects • Moderate carcinogenicity and mutagenicity • Moderate reproductive toxicity	• Very high persistence • High acute aquatic toxicity • Moderate chronic aquatic toxicity
Melamine **108-78-1**	Possible Benchmark 1 Avoid	• Moderate carcinogenicity • High to moderate endocrine activity	• Very high to high persistence

GreenScreen® for Safer Chemicals explained:

This assessment tool evaluates the hazards inherent in a chemical. It does not evaluate hazards presented by a material or product made with the chemical.

All data are from the Chemical Hazard Data Commons that uses GreenScreen® for Safer Chemicals as the framework for characterizing hazards associated with chemicals. GreenScreen is a transparent, open standard for hazard assessment designed to identify chemicals of high concern and safer alternatives. There are two types of scores given to chemicals: a GreenScreen **Benchmark** score (given as *Benchmark* 1 to 4, with 1 being the worst) or a GreenScreen **List Translator** score (given as *Possible Benchmark* or *Likely Benchmark* 1 to 4, with 1 being the worst). A **Benchmark** score results from a comprehensive GreenScreen Assessment by a Licensed GreenScreen Profiler. A **List Translator** score is based on lists of chemical hazards from scientific bodies or governments' chemical bans and policies. "Possible Benchmark" indicates less confidence in the source list(s) and "Likely Benchmark" indicates higher confidence.

In this table, all chemicals have been screened to see if they are on any lists from government or scientific bodies. Some chemicals have also gone through the full GreenScreen Assessment by a Licensed GreenScreen Profiler and have a Benchmark score reported. Chemicals for which only the List Translator has been applied have List Translator scores reported. More information about GreenScreen and List Translator can be found at https://www.greenscreenchemicals.org.

Benchmark 1: Avoid – chemical of high concern
Benchmark 2: Use but search for safer substitutes
Benchmark 3: Use but still opportunity for improvement
Benchmark 4: Prefer – safer chemical