

www.**HealthyCar**.org

The Consumer Guide To Toxic Chemicals in Cars

MODEL YEAR **2008/2009** GUIDE TO NEW VEHICLES

A REPORT BY THE ECOLOGY CENTER

AUTHORS

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ECOLOGY CENTER

The Ecology Center is a Michigan-based nonprofit environmental organization that works for a safe and healthy environment where people live, work and play. The Center's Clean Car Campaign works to address environmental and health impacts of the production, use and disposal of vehicles in the U.S.



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INTRODUCTION

Smog checks are required in some states to limit pollution coming out of cars. But what about a car's *indoor* air pollution?

Consumers are increasingly concerned about toxic chemicals that off-gas and leach from interior auto parts such as steering wheels, dashboards and seats. In addition to contributing to "new car smell," these chemicals can be harmful when inhaled or ingested and may lead to severe health impacts such as birth defects, learning disabilities and cancer. Since the average American spends more than 1.5 hours in a car every day¹, toxic chemical exposure inside vehicles is becoming a major source of potential indoor air pollution. While the emphasis of this study is on the exposure to toxic chemicals during the use phase of vehicle life, our rating system also considers potential health and environmental impacts during the production of materials and end-of-life of vehicles.

The good news is that some cars are better than others. Toxic chemicals are not required to make indoor auto parts, and some manufacturers have begun to phase them out. Scientists and researchers at the Ecology Center have created www.HealthyCar.org so that consumers can access information about the chemicals used in their car or the car they are thinking of purchasing. In addition to gas mileage and crash test ratings, car-buyers can now learn if the materials in their car are safe for themselves and their family.

USING THE GUIDE

HealthyCar.org includes test results from approximately 450 of the most popular vehicles in the U.S. market between model years 2006-2009. Vehicles were sampled during two testing periods. The first sampling phase included vehicles of model years 2006 and 2007 that were sampled from October to December of 2006. The

¹ Dong, L.; Block, G.; Mandel, S. 2004. Activities contributing to total energy expenditure in the United States: Results from the NHAPS study. *Int. J. Behavioral Nutrition Phys. Activity* 2004, 1, 4.

second sampling phase was conducted from April to June of 2008 and included vehicles with model years ranging from 2007 to 2009. Due to constant turnover of vehicles at a dealership, sampling was restricted to the models and model years available on the dealer's lot on the day of sampling.

HealthyCar.org 2008 includes test results from over 220 of the most popular vehicles in the U.S. market from the 2008 and 2009 model years. In each vehicle, 11 different components were sampled using a portable, hand-held X-Ray Fluorescence² (XRF) spectrometry device. The components sampled include: steering wheel, shift knob, armrest/center console, dashboard, headliner, carpet, seat front, seat back, seat base, hard and soft door-trim. The XRF device identified the elemental composition of each of these components. XRF tests are limited to analysis of elements and do not reveal the compounds containing a particular element. For example, the presence of chlorine indicates a chlorine-containing compound, such as PVC. Based on our findings, each vehicle was given an *overall vehicle rating*, as well as *chemical ratings* for bromine, chlorine, lead and a group of substances referred to as "other chemicals"³. A detailed description of the rating system is provided in the Appendix.

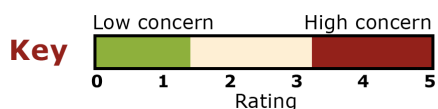
The *overall vehicle rating* indicates the relative level of health and environmental concern associated with the materials in the vehicle, in comparison to all other vehicles tested. The ratings range from 0 to 5, with 0 representing vehicles with the relative lowest concern and 5 the relative highest.

Each vehicle is also assigned a relative level of concern of *low*, *medium* or *high*. Vehicles with a *low* rating are indicated in green.

² More information about X-Ray Fluorescence (XRF) spectrometry can be found in the Appendix. More information about the XRF device used by HealthyCar.org can be found at: <http://www.innov-x-sys.com/home.php>

³ Other chemicals include: antimony, arsenic, chromium, cobalt, copper, mercury, nickel and tin.

Vehicles with a *high* rating are indicated in red. All others received an average or *medium* rating and are indicated in yellow.



The chemical ratings for bromine, chlorine, lead and other chemicals indicate the relative concern associated with levels of those elements detected in the vehicle, compared to all other vehicles tested. These ratings also range from 0 to 5, with 0 representing vehicles with the relative lowest concern and 5 the relative highest.

Table 1 below is a sample of the vehicle ratings for the station wagon class of vehicles.

In addition, the online guide provides the detection information for bromine, chlorine, lead, antimony, arsenic, chromium, cobalt,

Table 1: Vehicle Rating for 2007 Station Wagon Market Class

	OVERALL RATINGS	BROMINE	CHLORINE	LEAD	OTHER CHEMICALS
Volvo V50	0.8	0.2	0.6	0.3	1.0
Suzuki Aerio	0.8	0.4	0.3	0.0	1.3
Toyota Matrix	1.0	0.7	0.0	0.0	2.0
Suzuki SX4	1.1	1.0	0.3	0.6	1.2
Pontiac Vibe	1.2	0.3	0.6	1.9	1.9
Volvo V70	1.7	0.6	1.5	0.6	1.7
Saab 9-5	1.9	0.2	1.8	0.0	2.5
Audi A3	2.9	0.5	3.2	1.4	1.8
Mercedes E350	2.9	0.2	2.6	2.5	3.5
Mazda 5	3.2	2.9	0.9	1.9	3.6
Suzuki Forenza Wagon	4.1	2.6	2.1	4.4	4.0
Scion xB	4.3	4.9	0.6	3.9	3.7

Table 2: Sample Data - Concentrations found in a 2007 Pontiac Vibe

COMPONENT	BROMINE		CHLORINE		LEAD	
	PPM	Rank %	PPM	Rank %	PPM	Rank %
Arm rest/center console	0	0%	0	0%	0	0%
Carpet	9	63%	0	0%	16	90%
Door trim (hard)	0	0%	0	0%	0	0%
Door trim (soft)	78	70%	0	0%	0	0%
Exterior window seal	0	0%	451,663	88%	14	0%
Front seat (front)	0	0%	0	0%	0	0%
Front seat (rear)	0	0%	0	0%	0	0%
Headliner	6	46%	0	0%	15	91%
IP	0	0%	0	0%	0	0%
Seat base	0	0%	0	0%	0	0%
Shift knob	0	0%	174,885	83%	0	0%
Steering wheel	0	0%	0	0%	0	0%

copper, nickel, mercury and tin in parts per million in each individual vehicle component that was tested. A sample of this data is shown in Table 2. It also indicates the percent rank of any individual sample, as compared to the same component in other vehicles.

HealthyCar.org ratings do not provide any absolute measure of health risk or chemical exposure associated with any individual vehicle, or any individual element or related chemical. HealthyCar.org ratings only provide a relative measure of "level of concern" for a vehicle in comparison to all vehicles sampled.

In addition to toxic chemicals, consumers might also want to consider other issues, such as fuel-economy and safety, when considering a vehicle purchase. Visit HealthyCar.org to find links to other helpful vehicle shopping tools and answers to frequently asked questions.

CHEMICALS OF CONCERN

Indoor auto parts contain chemicals that are added during the production processes to impart specific properties such as rigidity, durability or flame resistance. Many of these chemicals are not chemically bound to the parts and are consequently released into the environment during the life of the product. One of the common ways chemicals are released is referred to as "off-gassing," and evidence of this is sometimes present as a window film or "fogging" that develops on the inside of the windshield. Heat can accelerate this process and UV-ray exposure may also cause chemicals to break down into more toxic compounds. These chemicals are inhaled or ingested by drivers and passengers through dust and air, potentially causing allergic or other acute reactions, or even long-term health impacts such as birth defects, impaired learning, liver toxicity and cancer.

The same chemicals that may cause human health problems due to exposure inside vehicles can also cause problems in the general environment. When vehicles are discarded at the end of their life, the majority of plastic and other nonmetallic parts are shredded and put into landfills or burned in incinerators. When discarded in landfills, harmful chemicals contained in vehicle plastics and other materials can leach out and contaminate soil and water. When incinerated, toxic chemicals are dispersed throughout the atmosphere.

While there are numerous chemical compounds in vehicles that may lead to health and environmental problems, HealthyCar.org focuses on chemicals containing the elements bromine, chlorine, and lead, as well as other heavy metals, allergens and carcinogens. All of these elements and their related chemical compounds were chosen because of their toxicity, persistence, and tendency to build up in people and the environment.

These substances were also chosen because they could be easily and quickly identified using non-destructive methods. This was essential since sampling for HealthyCar.org was limited to new vehicles. In addition, these substances, or their related molecular compounds, have been subject to either regulatory restrictions or voluntary limits set by industry associations or third party environmental certification organizations.

HealthyCar.org ratings do not provide any absolute measure of health risk or chemical exposure associated with any individual vehicle, or any individual element or related chemical. HealthyCar.org ratings only provide a relative measure of "level of concern" for the vehicles sampled. The ratings allow comparison between vehicles based on the presence and levels of chemicals of concern detected in the vehicles.

BROMINE

Detection of bromine in a vehicle component indicates the likely presence of a brominated flame retardant (BFR). A number of different BFRs are commonly used in vehicle components. While the sampling conducted for HealthyCar.org could not identify the chemical structure of the brominated flame retardant in a particular component, automakers in generally use the following three BFRs.

Deca-Brominated Diphenyl Ether

One of the most common BFR used in auto applications in the U.S. is deca-brominated diphenyl ether (decaBDE, or "deca")⁴. Deca is also used in many other products, including furniture, mattresses, televisions, and computers. In 2003, over 56,000 tons were used worldwide⁵. Deca is used at loadings of 10-15% weight in polymers and

⁴ Stuer-Lauridsen, F.; Havelund, S.; Birkved, M. 2000. Alternatives to brominated flame retardants, Screening for environmental and health data. Danish EPA. <http://www.mst.dk/homepage/> (Accessed 03/08/07).
⁵ Bromine Science and Environmental Forum. 2006. "Fact sheet: brominated flame retardant Deca-BDE." <http://www.bsef.com>. (Accessed 02/21/07).

is always used in conjunction with antimony trioxide⁶. Deca is physically mixed into the plastic during production and can be released to the environment over the life a product. It is becoming ubiquitous in homes, offices, and even the outdoor environment.

One of the major concerns with deca is that it may “debrominate,” or break down when exposed to UV radiation. Some of the breakdown products include pentaBDE and octaBDE, which have been phased-out by government health organizations and the global automotive industry, due to their toxicity. This is of particular concern to drivers and passengers since vehicle components that contain deca are exposed to high UV levels and heat when parked in the sun. In a recent report, research conducted by the Ecology Center testing found that concentrations of penta, octa and deca were much higher in dust and window film samples from new model vehicles than from samples obtained in homes and offices⁷. Once released from products, these chemicals remain in the environment for long periods and build up in people's bodies, in breast milk, and in fish and other animals⁸.

Exposure to deca is linked to a number of human health effects. Deca may pass through the placenta⁹ and cause neuro-developmental toxicity in unborn babies¹⁰.

⁶ Stuer-Lauridsen, F.; Havelund, S.; Birkved, M. 2000. Alternatives to brominated flame retardants. Screening for environmental and health data. Danish EPA.

<http://www.mst.dk/homepage/> (Accessed 03/08/07).

⁷ Ecology Center. 2006. “Toxic at any speed: chemicals in cars and the need for safe alternatives.”

<http://www.ecocenter.org/toxicatany-speed.shtml>. (accessed 02/21/07).

⁸ Rayne S, Ikonomou MG, Antcliffe B. 2003. “Rapidly increasing polybrominated diphenyl ether concentrations in the Columbia River system from 1992 to 2000.” *Environmental Science and Technology*. Jul 1: 37(13): 240A-241A.

⁹ Mazdai A, Dodder NG, Abernathy MP, Hites RA, Bigsby RM. 2003. “Polybrominated Diphenyl Ethers in Maternal and Fetal Blood Samples.” *Environmental Health Perspectives*. 111: 1249-1252.

¹⁰ Porterfield, S.P. 1994. “Vulnerability of the developing brain to thyroid abnormalities: environmental insult to the thyroid system.” *Environmental Health Perspectives* 102(supplement 2): 125-30.

Other suspected health concerns for polybrominated diphenyl ethers (PBDEs) include: thyroid hormone disruption¹¹, permanent learning and memory impairment¹², behavioral changes, hearing deficits, delayed puberty onset, decreased sperm count¹³, fetal malformations^{14,15} and possibly cancer¹⁶. Its breakdown products, pentaBDE and octaBDE as well as other lower brominated BDEs, have been linked to similar health effects. Levels in the environment are close to those levels in which health effects are seen in animal studies. .

Alternatives to deca and BFRs in general exist and are readily available on the market. Testing for HealthyCar.org found that for each component tested, numerous models did not contain any bromine, showing that automakers have met stringent fire safety codes without using decabDE or other BFRs. For further discussion of alternatives see the alternatives section below.

Many companies are voluntarily eliminating their use of deca. The use of deca has been restricted in electronics and electrical equipment in the European Union as of 2006. Some computer companies

¹¹ Zhou T, Taylor MM, DeVito MJ, Crofton KM. 2002. “Developmental exposure to brominated diphenyl ethers results in thyroid hormone disruption.” *Toxicology Science* Mar; 66(1): 105-16.

¹² Eriksson P, Jakobsson E, Fredriksson A. 2001. “Brominated flame retardants: a novel class of developmental neurotoxicants in our environment?” *Environmental Health Perspectives* Sep; 109(9): 903-8.

¹³ Kuriyama, S. and Chahoud, I. 2003. “Maternal exposure to low dose 2,2',4,4',5 pentabromo diphenyl ether (PBDE 99) impairs male reproductive performance in adult male offspring.” *Organohalogen Compounds* (61): 92- 95.

¹⁴ International Program of Chemical Safety (IPCS). 1994. “Brominated Diphenyl Ethers. Environmental Health Criteria 162. World Health Organization.”

¹⁵ Norris, J.M.; Kociba, R.J.; Scwetz, B.A.; Rose, J.Q.; Humiston, C.G.; Jewett, G.L.; Gehring, P.J.; Mailhes, J.B. 1975. “Toxicology of octabromobiphenyl and decabromodiphenyl oxide.” *Environmental Health Perspectives*. (11): 153-161.

¹⁶ U.S. Environmental Protection Agency. 2006. “Decabromodiphenyl ether (DBDPE) (CASRN 1163-19-5)” <http://www.epa.gov/iris/subst/0035.htm>. (Accessed 12/12/06).

began phasing out deca even before this restriction was put in place¹⁷.

While our testing did not conclusively determine the chemical form of bromine found in vehicle components, the most common forms of BFRs are well known. Other BFRs other than deca that could be contained in the auto parts are listed below, though their use in auto interiors is limited.

Tetrabromobisphenol A

TBBPA is another type of BFR that is commonly used in plastic applications. Over 130,000 tons were used in 2002 around the world, predominantly in circuit boards for electronics, but also in acrylonitrile butadiene styrene (ABS)¹⁸. TBBPA is known to off-gas to the environment, though the amount of off gassing varies depending how the TBBPA was combined with the plastic¹⁹. Lab tests have suggested that it may disrupt thyroid function²⁰. Studies also suggest that it may adversely affect hormone levels and the immune system²¹.

The use of TBBPA can be eliminated by replacement with available alternatives. Many electronics companies are voluntarily removing TBBPA from their products. Sony Ericson has promised to eliminate it in circuit boards by 2007, Dell by 2009. Meanwhile, Motorola and Fujitsu Siemens Computers have begun introducing TBBPA-free and BFR-free products to the market. They are able to do this by substituting TBBPA in circuit boards with phosphorous-based alternatives that are

¹⁷ Clean Production Action. 2006. "Safer Products: Computers." <http://www.safer-products.org/page.php?p=hous&ts=comp>. (Accessed 03/01/07).

¹⁸ Bromine Science and Environmental Forum. 2006. "Fact sheet: brominated flame retardant TBBPA." <http://www.bsef.com>. (Accessed 02/21/07).

¹⁹ Birnbaum L, Staskal D. 2004. "Brominated flame retardants: cause for concern?" *Environmental Health Perspectives* Vol. 112:1.

²⁰ Kitamura S, Kato T, Iida M, Jinno N, Suzuki T, Ohta S, Fujimoto N, Hanada H, Kashiwagi K, Kashiwagi A. 2005. "Anti-thyroid hormonal activity of tetrabromobisphenol A, a flame retardant, and related compounds: Affinity to the mammalian thyroid hormone receptor, and effect on tadpole metamorphosis." *Life Sciences*. 2005 Feb 18; 76(14): 1589-601.

²¹ Birnbaum L, Staskal D. 2004. "Brominated flame retardants: cause for concern?" *Environmental Health Perspectives*. Vol. 112:1.

capable of meeting the same fire safety regulations^{22,23}.

Hexa-Bromocyclododecane

HBCD is used in extruded polystyrene for thermal insulation foams and is also applied in the back coating of textiles for furniture. It is produced in much smaller quantities than deca and TBBPA, but is still substantial, with 16,700 tons used worldwide in 2001²⁴. Use of HBCD increased in recent years as it began to be used as a substitute for penta and octa after these chemicals were banned by the European Union. HBCD has a very strong propensity to bioaccumulate and is found in increasing concentrations in the environment. Studies suggest that HBCD affects thyroid hormone levels, causes learning and memory defects in neonatal laboratory animals, and has been detected in breast milk²⁵. In general, research is limited and more studies are needed in order to understand the extent of human health and environmental impacts caused by HBCD.

CHLORINE

Detection of chlorine in a vehicle component indicate the likely use of PVC, a widely used type of plastics that is of concern to the environment and public health during all phases of its life cycle. During the production phase, workers at PVC facilities, as well as residents and wildlife in surrounding neighborhoods, may be exposed to the vinyl chloride monomer and/or dioxin, both of which are likely carcinogens²⁶. At the end of vehicle

²² Green Peace. 2006. "Guide to Greener Electronics." <http://www.greenpeace.org/usa/press/reports/guide-to-greener-electronics>. (Accessed 03/01/07)

²³ Environmental Data Services Ltd. 2006. "Search continues for alternatives to TBBA." *ENDS Report* 384. January 2006.

²⁴ Bromine Science and Environmental Forum. 2006. "Fact sheet: brominated flame retardant HBCD." <http://www.bsef.com>. (Accessed 02/21/2007).

²⁵ Birnbaum L, Staskal D. 2004. "Brominated flame retardants: cause for concern?" *Environmental Health Perspectives* Vol. 112:1.

²⁶ The Center for Collaborative on Health and the Environment. 2006. "CHE Toxicant and Disease Database: Vinyl chloride and dioxins." <http://database.healthandenvironment.org/index.cfm> (See -

life, PVC causes a host of additional environmental issues. PVC is not easily recycled from auto parts and therefore often ends up in landfills, where the chemicals can leach out and contaminate soil, water and wildlife. Otherwise, it is incinerated or burned for energy recovery, in which case highly toxic dioxins and furans can form and be emitted into the air.

Flexible PVC often contains plasticizers, or “softeners,” called phthalates, which off-gas during vehicle use and are deposited on dust particles and windshields, where they cause “fogging.” One of the most common phthalates used, DEHP (di 2-ethyl-hexyl phthalate), has been linked to a number of serious health problems. The EPA classifies it as a probable human carcinogen²⁷, and there is also evidence that it causes male and female genital and urinary malformations, pre-term deliveries, and testicular atrophy²⁸. Short-term high exposure to DEHP interferes with sperm formation in mice and rats as well as delayed sexual maturity. Long-term exposure affects the liver and testes, and in some cases thyroid, ovaries, kidneys, and blood²⁹. Studies on animals suggest that DEHP, or some of its breakdown products, pass across the placenta and reach the fetus, causing birth defects, alterations in the structure of bones, brain, liver, kidney, and testes of the young animals, and even fetal death³⁰. Studies have also shown that DEHP, or some of its breakdown products, can pass from mother to babies through

breast milk and alter the development of the young animals³¹.

PVC-free alternatives are available for almost every use of PVC in the automotive sector. In recent years, automakers have begun replacing PVC with polyurethanes and polyolefins, which contain fewer harmful additives and are easier to recycle. In the event that an automaker cannot avoid using PVC, the phthalates in the PVC should be replaced with alternative plasticizers. Higher price is currently the biggest barrier to substitution of phthalates and PVC. Some automakers are getting close to eliminating PVC, but others still have a long way to go. For information on automakers’ policies regarding the use of PVC and other types of plastics, refer to the Ecology Center’s 2006 Automotive Plastics Report Card³².

A second common use of chlorine in plastics is chlorinated paraffins, which are by far the most widely used aliphatic chlorine-containing flame retardants. They have applications in plastics, including PVC, fabrics, paints and coatings. They may be present in the vehicles components that were found to contain chlorine.

Since there are no indications of the use of inorganic forms of chlorine (e.g. chlorides) in interior automotive applications, we assume that XRF detectable concentrations of chlorine above 10,000 ppm (1%) indicate the presence of organic chlorine compounds, such as PVC and other chlorinated hydrocarbons. Depending on the percentage of additives, such as stabilizers, plasticizers, and flame retardants, the chlorine content of PVC ranges between 28 and 57% by weight (280,000-570,000 ppm)³³. Since all chlorine detection levels in HealthyCar.org testing

Science, Toxics Database, Browse by Toxicant, Vinyl Chloride and Dioxins) (Accessed 03/01/07).

²⁷ U.S. Environmental Protection Agency. 2006. “Di(2-ethylhexyl)phthalate (DEHP) (CASRN 117-81-7).” <http://www.epa.gov/iris/subst/0014.htm>. (Accessed 12/13/06).

²⁸ The Center for Collaboration on Health and the Environment. 2006. “CHE Toxicant and Disease Database: di-2 ethylhexyl phthalate.” <http://database.healthandenvironment.org/index.cfm>. (See - Science, Toxics Database, Browse by Toxicant, di-2 ethylhexyl phthalate.) (Accessed 12/13/06).

²⁹ Agency for Toxic Substances and Disease Registry. 2006. “Public Health Statements: Di(2-ethylhexyl)phthalate (DEHP).” <http://www.atsdr.cdc.gov/toxprofiles/phs9.html>. Accessed 12/13/06.

³⁰ Ibid.

³¹ Ibid.

³² Ecology Center. 2006. “Automotive Plastics Report Card.” <http://www.ecocenter.org/sustainableplastics/> (Accessed 12/13/06).

³³ European Council of Vinyl Manufacturers. 2007. The role and origins of PVC. http://www.ecvm.org/code/page.cfm?id_page=108 (Accessed 03/16/07)

were found to be consistent with these levels, it is likely that detection of chlorine indicates the use of PVC in all vehicle components we tested.

LEAD

Lead is sometimes used as an additive in automotive plastics such as PVC and is also commonly used in wheel weights and solder. The European Union began restricting some of these uses of lead in automotive applications in accordance with its End of Life Vehicle Directive issued in 2000. Since then, many auto companies have significantly reduced their use of lead, but nonetheless it is still found in many vehicle components in the U.S.

The link between lead exposure and a number of severe health effects is well established. Long-term exposure in children can affect a child's growth, damage kidneys, and cause learning and behavioral problems, as well as possible brain damage³⁴. In adults, exposure to lead can increase blood pressure, cause kidney damage, nerve disorders, reproductive problems, and other health problems³⁵. The Department of Health and Human Services has determined that lead and lead compounds are reasonably anticipated to be human carcinogens. Lead also causes environmental concerns when disposed of in landfills or incinerated at the end of vehicle life because it can contaminate water, soil, air and wildlife.

OTHER CHEMICALS, ALLERGENS AND HEAVY METALS

XRF measurements of interior car components also revealed the presence of several other elements and chemical compounds containing these elements.

³⁴ Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for lead." <http://www.atsdr.cdc.gov/toxprofiles/phs13.html#bookark06>. (Accessed 03/01/07).

³⁵ Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for lead." <http://www.atsdr.cdc.gov/toxprofiles/phs13.html#bookark05>. (Accessed 03/01/07).

Since these are known to cause health and environmental problems at varying degrees depending on concentration and application, they were included in our evaluations, but at a lesser relative weight than bromine, chlorine and lead. Voluntary and mandatory safety standards for most of these chemicals have been published both in the U.S. and Europe, particularly for applications involving direct human contact, such as with toys. The "levels of concern" in these standards — based either on leaching tests or the percent by weight of the element contained in a material — are typically much lower than levels found by XRF analyses of car components. All of these chemicals may be released from plastics or fabrics due to abrasion or evaporation. It must be noted that the presence of low-level toxic metals in cars also has the potential for negative environmental impacts during the end-of-life processing of vehicles. Plastics and fabrics usually end up in automotive shredder residue (ASR) from which they may be released to the broader environment.

Antimony

DecaBDE and other BFRs are commonly combined with antimony trioxide during the production process to increase fire resistance³⁶. Antimony is also used as a catalyst in the production of polyesters³⁷. In our testing we found both lower levels of antimony (160-700 ppm range) that are consistent with polyester applications, as well as higher levels (2000-5000 ppm range) that may be consistent with flame retardant applications^{38,39}. In either case, it is possible

³⁶ Stuer-Lauridsen, F.; Havelund, S.; Birkved, M. 2000. Alternatives to brominated flame retardants, Screening for environmental and health data. Danish EPA. <http://www.mst.dk/homepage/> (See: publications, publications database, type title.)

³⁷ Victor-Innovatex, Inc. 2006. Sustainable Textile Design at Victor Innovatex. www.victor-innovatex.com/doc/sustainability.pdf. (Accessed on 02/25/07).

³⁸ Survey of chemical substances in textile colorants, in Survey of Chemical Substances in Consumer Products, No. 58 2005, Danish Ministry of Environment, Environmental Protection Agency, 2005.

³⁹ International Antimony Oxide Industry Association, Antimony Trioxide Frequently Asked Questions:

that antimony is released from the material, contaminating the air and dust inside vehicles.

Antimony trioxide is classified as a carcinogen in the state of California and has been listed as a possible human carcinogen by the International Agency for Research on Cancer⁴⁰ and the European Union⁴¹. In long-term studies, animals that breathed very low levels of antimony had eye irritation, hair loss, lung damage, and heart problems. Higher levels of antimony have been shown to cause fertility problems and lung cancer in animals⁴².

Arsenic

In automotive applications, arsenic is traditionally used as a biocide in coated fabrics⁴³. Arsenic is a known human carcinogen⁴⁴. There is strong evidence that arsenic is linked to lung, skin, and bladder cancer⁴⁵. It may also cause skin irritation, blood disorders, cardiovascular diseases, and hormone disruption⁴⁶.

March 2006

⁴⁰ Stuer-Lauridsen, F.; Havelund, S.; Birkved, M. 2000.

"Alternatives to brominated flame retardants, Screening for environmental and health data." Danish EPA. <http://www.mst.dk/homepage/> (See: publications, publications database, type title.)

⁴¹ European Commission. 2007. "The Directive on Dangerous Substances."

http://ec.europa.eu/environment/dansub/consolidated_en.htm. (Accessed 03/01/07).

⁴² Agency for Toxic Substances and Disease Registry. 2006. Public health statement for antimony.

<http://www.atsdr.cdc.gov/toxprofiles/phs23.html>. (Accessed 03/01/07).

⁴³ Inventory of biocides used in Denmark, Danish Environmental Protection Agency. Environmental Project no. 585, 2001.

http://glwww.mst.dk/udgiv/Publications/2001/87-7944-383-4/html/helepubl_eng.htm (Accessed 03/01/07)

⁴⁴ Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for arsenic."

<http://www.atsdr.cdc.gov/toxprofiles/phs2.html#bookmar k05>. (Accessed 03/01/07).

⁴⁵ The Collaborative on Health and the Environment. 2006. "CHE Toxicant and Disease Database: Arsenic."

<http://database.healthandenvironment.org/index.cfm> (See - Science, Toxics Database, Browse by Toxicant, Arsenic). (Accessed 03/01/07).

⁴⁶ Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for arsenic."

<http://www.atsdr.cdc.gov/toxprofiles/phs2.html#bookmar k05>. (Accessed 03/01/07).

Chromium

In vehicles, the presence of chromium compounds is often linked to leather tanning⁴⁷. Our vehicle testing confirmed that chromium (most likely chromium Cr(III)) was often used in leather seating applications. Approximately 90% of all leather is tanned with Cr(III)⁴⁸. Chromium compounds may be released from leather upholstery as the material is abraded during the life of the product. The toxicity of chromium strongly depends on the oxidation state of this element, two of the most common forms are the less toxic Cr (III) and the highly toxic Cr (VI) state. XRF does not however distinguish between oxidation states and only indicates the presence of the element chromium.

While chromium is an essential nutrient⁴⁹, the limit level of chromium in fabrics, leathers and plastics established to be protective from allergic reactions <50 ppm⁵⁰. HealthyCar.org revealed levels greater than this in automotive seating. There is strong evidence that chromium can cause asthma attacks and other allergic reactions, bronchitis and lung conditions, skin irritation, and kidney disorders⁵¹. There is also evidence that exposure to chromium may cause brain cancer, photosensitivity, stomach cancer, and possibly reduced fertility, immune system disorders, adult-onset Leukemia and other cancers⁵².

⁴⁷ Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for chromium."

<http://www.atsdr.cdc.gov/toxprofiles/phs7.html#bookmar k01>. (Accessed 03/01/07).

⁴⁸ International Council of Tanners. 2003. Perspective on leather. <http://www.tannerscouncilct.org/perspective.htm> (Accessed 03/01/07)

⁴⁹ Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for chromium."

<http://www.atsdr.cdc.gov/toxprofiles/phs7.html#bookmar k01>. (Accessed 03/01/07).

⁵⁰ TÜV Rheinland SG Standard for low polluting leathers, fabrics and plastics, 2001

[http://www.tuvdotcom.com/pi/web/TuvdotcomIdSearch Results.xml?TUVdotCOMID=4111008300&LanguageChange d=en-us](http://www.tuvdotcom.com/pi/web/TuvdotcomIdSearchResults.xml?TUVdotCOMID=4111008300&LanguageChange d=en-us) (Accessed 03/01/07)

⁵¹ The Collaborative on Health and the Environment. 2006. "CHE Toxicant and Disease Database: Chromium."

<http://database.healthandenvironment.org/index.cfm> (See - Science, Toxics Database, Browse by Toxicant, Chromium). (Accessed 03/01/07).

⁵² Ibid.

Cobalt

Cobalt is used as a catalyst in production of polyethylene and other plastics⁵³. It can also be used as pigment in paints⁵⁴.

HealthyCar.org detected cobalt in several different vehicle components.

Cobalt is essential in trace amounts for human life. The toxicity of cobalt is quite low compared to many other metals, however high exposure can cause several health effects. Cobalt is an allergen that can cause asthma and skin irritation⁵⁵. Some cobalt compounds are classified as a possible human carcinogen according to the International Agency for Research on Cancer⁵⁶. Long term exposure to low doses results in damage to the heart, liver, kidneys, blood, testes, and behavioral changes in laboratory animals⁵⁷. There is also strong evidence that cobalt is linked to hearing loss, lung disorders, and thyroid disorders. There is limited evidence that it causes lung cancer, damage to the pancreas, and skin cancer⁵⁸.

Copper

Copper has a number of uses in fabrics and

plastics. Copper ions are often added to polyester and a variety of other fibers, ranging from cotton to rayon, polypropylene and nylon in order to protect against bacteria, fungus and odors^{59,60}. The main applications in vehicles include seat upholstery, carpets, headliners and trunk liners. Copper may also be used in combination with flame retardants to reduce the toxicity of combustion emissions⁶¹.

Copper is an essential nutrient for all living things, but too much can be harmful. Long-term exposure to copper dust can irritate the nose, mouth and eyes, and cause headaches, dizziness, nausea and diarrhea⁶². Exposure to excess levels of copper may result in liver and kidney damage, and anemia⁶³. Children may be more sensitive to copper than adults⁶⁴.

Nickel

Automotive uses of nickel are wide ranging, including printed circuit boards in electronic components, batteries, valves and other applications. Nickel is also increasingly used in electroplating of plastic components.

The most common harmful health effect of nickel in humans is allergic reaction. Approximately 10-15% of the population is

⁵³ Basketter D.A.; Angelini G.; Ingber A.; Kern P.S.; Menné T., Nickel, chromium and cobalt in consumer products: revisiting safe levels in the new millennium. Contact Dermatitis, Volume 49, Number 1, July 2003

⁵⁴ Substitution of cobalt driers in wood coatings, Jakob Kjær Larsen, Dyrup A/S; Eva Wallström, EnPro ApS. Danish Minister of Environment, Environmental Protection Agency, Working Report No. 20 2006

⁵⁵ Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for cobalt." <http://www.atsdr.cdc.gov/toxprofiles/phs33.html>. (Accessed 03/01/07).

⁵⁶ International Agency for Research on Cancer. 2003. Cobalt in Hard-metals and Cobalt Sulfate, Gallium Arsenide, Indium Phosphide and Vanadium Pentoxide. International Agency for Research on Cancer. 2003. "Cobalt in Hard-metals and Cobalt Sulfate, Gallium Arsenide, Indium Phosphide and Vanadium Pentoxide." <http://monographs.iarc.fr/ENG/Meetings/vol86.php>. (Accessed 03/01/07).. Accessed on March 1, 2007.

⁵⁷ Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for cobalt." <http://www.atsdr.cdc.gov/toxprofiles/phs33.html>. (Accessed 03/01/07).

⁵⁸ The Collaborative on Health and the Environment. 2006. "CHE Toxicant and Disease Database: Chromium." <http://database.healthandenvironment.org/index.cfm> (See - Science, Toxics Database, Browse by Toxicant, Cobalt). (Accessed 03/01/07).

⁵⁹ Foss Manufacturing Company, LLC. http://www.fossmfg.com/bu_fosshield.cfm (Accessed 03/01/07)

⁶⁰ Advanced Seat Fabrics with High Performance Deodorant Function, R&D Review of Toyota CRDL Vol. 35 No. 4 (2000. 12)

⁶¹ PVC Additives Make Vinyl More Fire-retardant without Toxic Heavy Metals, Innovations Report. <http://www.innovations-report.de/html/berichte/materialwissenschaften/bericht-32741.html>. (Accessed 03/01/07)

⁶² Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for copper." <http://www.atsdr.cdc.gov/toxprofiles/phs132.html#bookmark05>. (Accessed 03/01/07).

⁶³ The Collaborative on Health and the Environment. 2006. "CHE Toxicant and Disease Database: Chromium." <http://database.healthandenvironment.org/index.cfm> (See - Science, Toxics Database, Browse by Toxicant, Copper). (Accessed 03/01/07).

⁶⁴ Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for copper." <http://www.atsdr.cdc.gov/toxprofiles/phs132.html#bookmark05>. (Accessed 03/01/07).

sensitive to nickel. Reactions may occur in the form of skin irritations or asthma⁶⁵. The Department of Health and Human Services has determined that nickel metal may reasonably be anticipated to be a carcinogen and that some nickel compounds are known human carcinogens.

Mercury

Mercury is used as a catalyst in reactions to form polymers⁶⁶. HealthyCar.org detected low concentrations of mercury in many different vehicle components.

Mercury is a persistent toxin that can build up in the body. According to the Department of Health and Human Services, long-term exposure to high levels of methylmercury or phenylmercury causes behavior changes and damage to the kidneys, stomach, large intestine, circulatory system, and reproductive organs in animals⁶⁷. The nervous system is more sensitive to methylmercury toxicity than are other organs in the body and is affected at lower concentrations. Animal studies also provide evidence that mercury damages the nervous system during development and increases the incidence of spontaneous abortions and stillbirths⁶⁸. It is not known whether mercury compounds cause cancer in humans.

Tin

Organic tin compounds are used as esterification catalysts in polyurethane foam production and polyvinyl chloride (PVC) heat stabilizers in plastic production. The major use of organotin compounds is for heat stabilization of PVC, which represents

approximately two-thirds of the global consumption⁶⁹.

Organotins may also be used as additives in fabrics and plastics due to their strong fungicidal and bactericidal properties⁷⁰. Exposure to some organic tin compounds can occur through contact with consumer

products that are made of PVC, polyurethane and other plastics, or when these products are abraded and turned into dust that is inhaled.

According to the Department of Health and Human Services, breathing, swallowing, or direct skin contact with some organotins can interfere with the way the brain and nervous system work. Some have also been shown to affect the immune and reproductive system in animals, though the effects depend on the exact compound used. Direct contact with certain organotins can also produce skin and eye irritation⁷¹.

ALTERNATIVES

When considering alternatives, automakers have the following three choices, listed in order of environmental preference:

1. *Change the product:* Redesign or engineer the auto component to eliminate the need for a chemical. This can be done, for example, by eliminating the need for foams that contain BFRs, or enhancing barriers between foam and fabric.
2. *Change the material:* Select an alternative material that does not require the chemical.
3. *Change the chemical:* For example, replace BFRs with an alternative flame retardant that is non-halogenated (i.e. does not

⁶⁵ Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for nickel." <http://www.atsdr.cdc.gov/toxprofiles/tps15.html#bookmark05>. (Accessed 03/01/07).

⁶⁶ Agency for Toxic Substances and Disease Registry. 1999. Toxicological Profile for Mercury, March 1999. <http://www.atsdr.cdc.gov/toxprofiles/tp46.html#bookmark08> (Accessed 03/01/07).

⁶⁷ Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for mercury." <http://www.atsdr.cdc.gov/toxprofiles/tps46.html#bookmark05>. (Accessed 03/01/07).

⁶⁸ Ibid.

⁶⁹ Agency for Toxic Substances and Disease Registry. 2005. "Toxicological Profile for Tin." <http://www.atsdr.cdc.gov/toxprofiles/tps55.html#bookmark09>. (Accessed 03/01/07).

⁷⁰ Ibid.

⁷¹ Agency for Toxic Substances and Disease Registry. 2006. "Public health statement for tin." <http://www.atsdr.cdc.gov/toxprofiles/tps55.html#bookmark05>. (Accessed 03/01/07).

contain bromine, chlorine or other halogens).

In addition to following this general approach, automakers should implement a comprehensive chemicals policy. Key elements of a comprehensive chemicals policy are outlined at HealthyCar.org. A overall approach to chemicals management is outline in the next section.

Roadmap for Comprehensive Chemicals Policy

HealthyCar.org urges auto manufacturers to adopt a comprehensive chemicals policy for their company. The elements of that policy should include:

1. Know what is contained in your products

- Know the chemical components of your products.
- Know the process chemicals required to make your products.
- Know the life-cycle impacts of your products including the chemicals released during product use, and their degradation and combustion byproducts.
- Signal vendors that complete chemical ingredient information will be required over time.

2. Prescreen all chemicals before use for safety

- Establish a baseline set of criteria that any chemical must meet in order to be used in company products. The criteria must be protective of children's health.
- All new chemicals the company contemplates using should receive the highest level screening, to prevent the integration of a new problem chemical into the company's manufacturing system.

3. Insure that all chemical components in existing products are tested to assess hazards

- Comprehensively assess all chemicals/materials in products for health/safety and environmental concerns throughout the life cycle of that chemical/material. Use screening tools where direct testing data is not available (the EPA has a series of on-line tools) to determine the hazard profile of all chemical components
- Initially screen all chemical components and process

chemicals against existing lists of chemicals of concern

- Work toward comprehensive testing (or urge upstream suppliers to provide comprehensive testing data) for key health and environmental endpoints of concern for children's health
- Evaluate all chemicals based on their inherent hazards, not on a risk characterization. Prioritization may incorporate risk characterization.
- Over time, only use chemicals that have been fully tested for their ability to harm health or the environment, and found to be less hazardous. Phase out chemicals that have not been tested.
- Signal vendors that complete chemical testing will be required for chemical components of products over time.

4. Eliminate the worst chemicals and commit to continuous improvement:

- Commit to use only inherently low hazard chemicals.
- Set goals for benchmarking progress to safer chemicals and prioritize high hazard chemicals for substitution with safer alternatives.
- Commit to eliminating lead, mercury, and cadmium and other persistent, bioaccumulative toxic chemicals immediately as a first step, and phase out the use of PVC with dangerous additives.

5. Prohibit chemicals with a high hazard profile.

- These may be chemicals that persist and bioaccumulate, chemicals that are known carcinogens, mutagens and reproductive toxicants, known neurotoxicants, ecologically harmful, etc. This list should go beyond regulatory requirements. The list should be developed by evaluating the inherent hazards of a chemical first, and then prioritizing based on a life cycle assessment of

the threats posed by the chemical/material. The list of attributes that are prohibited should grow over time, in order to achieve a chemical profile for the company that includes primarily low hazard chemicals.

6. Commit to continuous improvement in the toxicity profile of all chemicals used.

- Establish goals to reduce the overall toxicity profile for the company. Those goals should be reviewed regularly and should continually improve the chemical profile of the company. Develop metrics to capture cost savings and other benefits of the program. Align employee incentives with this goal.

7. Disclose ingredients:

- Label and bar code or otherwise provide health/safety/environmental attributes of products for consumers/user in a way that is easy for the consumer to access.

8. Publicly support government chemical reform measures:

- Companies can provide a powerful voice for change at the state and federal level. Individual chemicals policies by companies are an inefficient way to provide comprehensive testing information to all downstream users. Companies should support the reform of chemicals management laws so that adequate information on chemical impacts are provided to downstream users to choose the safest and most effective chemicals. Companies should also support the development of safer alternatives, and the creation of incentives to accelerate the development of safer materials

9. Be socially responsible:

- Contract from and operate facilities that meet basic human rights for

workers and provide safe and healthy workplaces.

10. Publicly disclose progress:

- Disclose the policy and progress towards achieving it on your company's website, in your annual CSR/sustainability reporting, and in the media.

For further information on how companies are leading in adopting chemicals policies, see a review of case studies of healthy business strategies <http://www.cleanproduction.org/HealthyBusiness.php>

HealthyCar.org testing found that some auto companies are producing vehicles that meet stringent safety standards without using harmful compounds like PVC and brominated flame retardants (BFRs) in the interior components tested. The chart below illustrates this. In 2008 overall, 38% of the components tested contained no PVC or BFRs.

Table 3: Number of Bromine & Chlorine Free Components - 2008 & 2009 Model Year Vehicles

Component	Number PVC Free		Number Br/BFR Free		Number Halogen Free		Number Br/BFR <100 ppm		Number Virtually Halogen Free*	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Armrest/Center Console	86 50%	104 48%	87 51%	137 63%	47 22%	57 26%	150 71%	181 83%	89 42%	81 37%
Carpet	171 99%	213 98%	93 54%	96 44%	107 51%	93 43%	145 69%	194 89%	175 83%	189 87%
Door trim (hard)	152 88%	199 91%	101 59%	159 73%	118 56%	146 67%	166 79%	215 98%	178 84%	195 89%
Door Trim (soft)	85 49%	98 45%	67 39%	140 65%	26 12%	42 19%	125 59%	179 82%	60 28%	63 29%
Exterior Window Seal	107 62%		135 78%		99 47%		167 79%		129 61%	
Front Seat (front)	164 95%	211 95%	25 15%	46 21%	33 16%	42 19%	107 51%	144 65%	124 59%	134 61%
Front Seat (rear)	96 56%	130 60%	66 38%	119 55%	27 13%	49 23%	130 62%	178 83%	68 32%	96 45%
Headliner	170 99%	210 97%	70 41%	116 54%	83 39%	110 51%	165 78%	202 94%	201 95%	196 91%
IP	138 80%	175 80%	97 56%	134 61%	101 48%	118 54%	167 79%	216 99%	163 77%	174 80%
Seat base	167 97%	217 99%	118 69%	162 74%	140 66%	160 73%	162 77%	212 96%	196 93%	209 95%
Shift Knob	123 72%	165 76%	104 60%	165 76%	77 36%	115 53%	166 79%	204 94%	134 64%	153 70%
Steering Wheel	166 97%	213 99%	92 53%	148 69%	107 51%	146 68%	153 73%	213 99%	200 95%	211 98%
All Components	1625 79%	1935 81%	1055 51%	1422 59%	965 38%	1078 45%	1803 71%	2138 89%	1717 68%	1701 71%

* We define Virtually-Halogen free as not containing any intentionally-added PVC or BFRs. Bromine found at levels <100 ppm are believed to be inconsistent with the use of BFRs.

VEHICLE GUIDE

This section lists the vehicle ratings for popular vehicles from the 2006, 2007, 2008 & 2009 model years. The vehicles are listed by market class and in order of lowest to highest relative concern. The overall vehicle rating, as well as ratings for bromine, chlorine, lead and other chemicals, are provided. Detailed information on the concentrations of elements found in particular components is available at www.HealthyCar.org.

2006 Model Year	Overall Rating	Bromine	Chlorine	Lead	MPG-Combined
Convertible					
BMW M3 Convertible (2006)	1.5	0.5	0.0	1.9	17
Pontiac G6 (2006)	1.8	0.7	0.9	1.9	24
Saab 9-3 Aero (2006)	2.0	0.4	1.5	1.9	21
Nissan 350Z Roadster Tour (2006)	2.4	1.4	1.2	0.3	19
Lexus SC 430 (2006)	2.9	0.8	2.4	0.0	19
VW Beetle (2006)	3.8	0.4	5.0	0.6	

Coupe					
Pontiac GTO (2006)	1.9	0.4	1.5	0.0	18
Toyota Solara (2006)	2.4	2.0	0.3	1.4	21
Chevy Monte Carlo (2006)	3.3	0.4	3.2	1.4	22

Family Sedan					
VW Passat (2006)	1.8	0.4	1.2	0.0	24
Toyota Prius (2006)	1.8	1.3	0.6	0.0	46
Buick Lacrose (2006)	1.9	0.8	0.9	0.0	21
Honda Accord (2006)	2.0	0.3	1.5	0.6	36
Chrysler Sebring (2006)	2.1	0.2	1.5	2.5	22
Dodge Charger RT (2006)	2.2	0.5	2.1	0.0	21
Hyundai Azera (2006)	2.2	1.2	0.6	0.8	20
Ford Fusion (2006)	2.3	0.3	2.6	0.0	24
Dodge Stratus (2006)	3.2	2.0	1.8	1.4	22
Kia Optima (2006)	3.5	1.5	2.1	3.9	23
Hyundai Elantra (2006)	3.7	2.3	2.4	3.3	26
Kia Spectra 5 (2006)	4.0	4.6	0.3	3.6	25

Heavy Duty Truck					
Hummer H2 (2006)	1.8	1.2	0.6	0.0	

Large Sedan					
Ford Crown Vic. (2006)	2.2	1.2	1.5	0.6	18
Chevy Malibu Maxx (2006)	2.4	0.7	1.5	1.7	22
Kia Amanti (2006)	2.8	0.7	2.4	0.8	18
Ford Five Hundred (2006)	2.9	0.4	2.9	0.8	21
Toyota Avalon (2006)	3.0	2.9	0.9	0.0	23
Chrysler SRT8/300C (2006)	3.1	1.8	2.1	1.4	15

Luxury Sedan					
Acura RL (2006)	1.3	1.2	0.0	0.0	19

Minivan					
Audi A6 (2006)	3.1	0.6	3.2	0.0	18
Honda Odyssey (2006)	0.8	0.4	0.0	0.0	20
Ford Freestar (2006)	1.5	0.5	0.9	0.0	18
Saturn Relay (2006)	1.9	0.4	1.5	0.0	19
Dodge Grand Caravan (2006)	2.4	0.5	2.4	0.0	20
Toyota Sienna (2006)	2.6	2.7	0.3	1.9	17
Pontiac Montana SV6 (2006)	2.7	2.2	0.6	1.4	19
Chevy Uplander (2006)	2.9	1.7	1.2	1.9	17
Kia Sedona (2006)	3.3	3.3	0.3	2.8	18
Chrysler Town & Country (2006)	3.7	0.6	4.1	0.6	18

Pickup Truck					
Nissan Frontier (2006)	1.0	0.3	0.6	0.0	21
Chevy Colorado 2WD (2006)	1.2	0.2	0.6	0.0	21
Nissan Titan (2006)	1.3	0.4	0.6	1.7	14
Toyota Tacoma (2006)	1.3	0.6	0.3	0.0	20
Ford F150 (2006)	1.4	0.6	0.9	0.3	15
Toyota Tundra (2006)	1.9	2.4	0.0	0.0	15
Mitsubishi Raider (2006)	2.2	0.7	1.5	0.6	17
Ford Ranger (2006)	2.4	2.8	0.0	3.3	17
Dodge Dakota Club Cab (2006)	2.8	2.8	0.6	0.8	17
Dodge Ram 2500 (2006)	3.0	1.8	1.5	1.9	

Small Car					
Suzuki Aerio Sedan (2006)	2.0	2.5	0.3	0.0	24
Mitsubishi Lancer (2006)	2.0	2.1	0.0	1.7	26
Scion tC (2006)	2.1	2.3	0.3	2.8	23
VW new GTI (2006)	2.2	0.8	1.8	0.0	25
Honda Civic (2006)	2.2	2.8	0.0	1.4	30
Toyota Corolla Le Sedan (2006)	2.2	2.1	0.3	1.4	31
VW Rabbit (2006)	2.5	1.1	2.1	0.6	22
Ford Focus (2006)	2.6	1.2	1.2	2.5	26
Subaru Impreza WRX (2006)	2.6	3.4	0.0	1.9	22
Scion xA 5 Door (2006)	3.0	2.9	0.3	1.9	30
Suzuki Reno (2006)	3.6	2.9	2.1	1.4	23
Suzuki Forenza (2006)	3.7	2.9	1.8	2.8	23
VW Jetta (2006)	3.7	0.7	4.4	0.0	30
Kia Rio (2006)	4.2	5.0	0.3	2.5	29

Sports/Sporty Car					
BMW Z4 3.0 (2006)	1.3	0.5	0.3	0.0	21
Mazda MX-5 Miata (2006)	1.4	0.5	0.6	0.0	24
Mazda RX-8 (2006)	1.8	1.3	0.3	0.0	19
Ford Mustang (2006)	2.1	1.0	0.9	1.9	20
Hyundai Tiburon (2006)	3.5	2.7	0.6	5.0	23

Sports/Sporty Car					
Suzuki Aerio (2006)	0.8	0.4	0.3	0.0	24
Toyota Matrix (2006)	0.9	0.7	0.0	0.0	29
Saab 9-5 2.3T (2006)	2.0	0.2	1.8	0.0	22
Audi A3 (2006)	3.0	0.5	3.2	1.4	25
Suzuki Forenza Wagon (2006)	4.1	2.6	1.8	4.4	22
Scion xB 5dr (2006)	4.2	4.9	0.3	3.9	28

SUV					
Chrysler PT Cruiser (2006)	0.8	0.1	0.9	0.0	22
BMW X3 (2006)	0.9	0.5	0.0	0.0	18
Honda CRV (2006)	1.0	0.4	0.3	1.4	22
Subaru Tribeca (2006)	1.2	0.5	0.0	0.6	18
Ford Explorer (2006)	1.4	0.4	0.9	0.0	16
Nissan XTerra (2006)	1.4	0.3	1.2	0.0	17
Suzuki XL7 (2006)	1.4	0.6	0.6	0.6	18
Chevy Equinox (2006)	1.4	0.3	0.6	0.0	18
Honda Pilot (2006)	1.6	1.0	0.3	0.0	17
Infiniti FX35 (2006)	1.6	0.7	0.6	1.1	18
Toyota 4 Runner (2006)	1.7	0.5	1.2	0.0	18
Acura MXD (2006)	1.7	1.0	0.6	0.0	17
Mercedes ML350 (2006)	1.7	0.2	1.5	0.0	16
Toyota Sequoia (2006)	1.8	0.5	1.2	0.0	14
Ford Expedition (2006)	1.9	0.7	1.5	1.1	14
Ford Freestyle (2006)	1.9	0.2	1.5	0.6	20
Nissan Murano (2006)	1.9	0.7	0.9	0.0	20
Jeep Jeep Liberty (2006)	2.0	0.3	1.8	0.0	21

Mitsubishi Outlander (2006)	2.1	2.1	0.3	1.4	22
Chevy Tahoe (2006)	2.1	0.5	1.8	0.0	16
Jeep Grand Cherokee (2006)	2.2	0.7	1.8	0.0	17
Lexus LX 470 (2006)	2.2	0.5	1.8	0.6	13
Volvo XC 70 (2006)	2.4	0.6	2.6	0.0	19
GMC Yukon (2006)	2.4	1.3	1.5	0.6	16
Honda Element (2006)	2.6	1.8	0.9	3.3	20
Chevy Trailblazer (2006)	2.7	0.3	2.9	0.0	16
Nissan Pathfinder (2006)	2.7	1.4	1.5	0.6	17
Hyundai Santa Fe (2006)	2.9	0.5	2.1	3.6	20
Kia Sportage (2006)	3.1	2.6	0.6	3.9	22
Jeep Commander (2006)	3.1	2.1	1.8	2.8	16
VW Touareg (2006)	3.2	0.6	2.9	1.9	17
GMC Envoy (2006)	3.2	0.5	3.2	0.0	17
Toyota Highlander (2006)	3.4	3.2	0.3	2.8	22
Hyundai Tucson V6 (2006)	3.5	3.3	0.0	2.5	22
Chrysler Pacifica FWD (2006)	3.6	2.3	2.4	1.4	17
Toyota Rav 4 (2006)	3.6	2.7	1.2	2.8	22
Kia Sorento (2006)	3.6	3.4	0.6	3.1	16

Upscale Sedan					
Acura TSX (2006)	1.3	0.6	0.0	0.0	23
Cadillac STS Lux (2006)	1.3	0.4	0.6	0.3	19
BMW 330 i (2006)	1.5	0.9	0.0	1.7	21
Acura TL (2006)	1.6	0.9	0.9	0.0	21
BMW 335i Coupe (2006)	1.6	0.5	0.6	1.4	
Saab 9-3 2.0T (2006)	1.7	0.3	1.5	0.6	23
BMW 325i Sedan (2006)	1.9	0.7	0.6	2.2	21
Audi A4 (2006)	3.1	0.8	3.2	0.6	24

2007 Model Year

Convertible

	Overall Rating	Bromine	Chlorine	Lead	MPG-Combined
Chevy Corvette (2007)	1.3	0.0	1.2	0.0	19
Mercedes SLK280 (2007)	1.3	0.4	0.0	0.0	20
Pontiac Solstice (2007)	2.1	0.2	1.5	0.0	22
Saturn Sky Roadster (2007)	2.3	1.0	1.5	0.0	22
VW EOS (2007)	2.3	0.4	2.6	0.6	24
Ford Mustang GT Coup. (2007)	2.3	0.7	1.5	0.6	20

Family Sedan

Toyota Prius (2007)	0.8	0.8	0.0	0.0	46
Nissan Maxima (2007)	1.6	0.4	0.9	1.1	21
Hyundai Sonata (2007)	1.8	0.2	0.9	0.0	25
Nissan Altima (2007)	2.2	2.3	0.0	3.6	26
Ford Fusion (2007)	2.6	0.4	2.6	0.3	23
Pontiac Grand Prix (2007)	2.7	2.3	1.2	0.3	21
Subaru Legacy (2007)	2.9	2.8	0.3	3.9	23
Toyota Camry (2007)	3.1	3.0	0.6	0.0	34
Mitsubishi Galant (2007)	3.1	1.0	2.9	0.8	23
Mazda Mazda 6 (2007)	3.1	0.5	2.9	0.3	24
Saturn Aura (2007)	3.1	0.6	2.6	1.9	21
Kia Optima (2007)	3.2	2.9	1.2	1.1	25
Mercury Milan (2007)	3.3	0.7	3.2	0.6	23

Family Sedan

Chevy Express (2007)	3.9	1.9	2.6	1.7	15
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Large Sedan

Mercury Grand Marquis (2007)	1.6	1.2	0.6	0.3	18
Buick Lucerne (2007)	2.0	0.6	1.5	0.6	20
Mercury Montego (2007)	2.1	0.7	1.5	0.6	21
Chevy Impala (2007)	3.5	2.4	2.6	1.4	22

Luxury Sedan

Lexus ES 350 (2007)	1.3	0.7	0.0	0.0	22
Cadillac DTS (2007)	1.5	0.5	1.2	0.0	18
BMW 530i Sedan (2007)	1.6	0.4	0.9	0.3	22
Mercedes CLS550 (2007)	1.7	0.4	0.6	0.0	16
Mercedes S550 (2007)	2.1	0.4	0.6	0.6	17
Infiniti M35 (2007)	2.2	1.1	0.9	0.0	19
BMW 525xi Sedan (2007)	2.8	0.4	2.4	0.6	20
Lincoln Town Car (2007)	3.2	1.6	2.9	0.8	18

Minivan

Hyundai Eutourage Ltd (2007)	1.5	1.3	0.0	0.0	18
Nissan Quest (2007)	1.5	1.1	0.6	0.3	19
Buick Terraza (2007)	1.7	0.4	0.9	0.0	19
GMC Savanna (2007)	3.5	1.9	2.6	1.9	16

Pickup Truck

Honda Ridgeline (2007)	1.0	0.2	0.3	0.0	17
GMC Canyon (2007)	1.1	0.5	0.6	0.0	20
GMC Sierra (2007)	1.7	0.6	1.2	0.0	17
Lincoln Mark LT (2007)	1.8	0.4	1.2	0.6	14
Toyota Tundra CMAX (2007)	2.4	2.0	1.2	1.4	14
Toyota Tundra (2007)	2.5	2.1	1.2	1.4	14
Dodge Ram 1500 (2007)	3.4	2.3	1.5	1.9	14
Chevy Silverado (2007)	3.9	2.9	1.5	3.9	17

Small Car

Chevy Cobalt (2007)	0.5	0.3	0.0	0.3	25
Pontiac G5 (2007)	1.1	0.3	0.3	0.0	25
BMW Mini Cooper Sample 1 (2007)	1.3	0.4	0.9	0.0	32
Honda Fit (2007)	1.4	0.9	0.0	0.0	31
Dodge Caliber (2007)	1.4	0.3	0.6	0.3	26
Nissan Sentra (2007)	1.6	1.1	0.9	0.0	28
BMW Mini Cooper Sample 2 (2007)	2.0	0.1	2.1	0.0	32
Saturn Ion 2 (2007)	2.2	2.4	0.3	0.0	26
Suzuki Forenza (2007)	3.0	2.6	1.8	0.6	23
Mitsubishi Eclipse (2007)	3.1	1.3	2.4	0.6	23
Mazda Mazda 3 (2007)	3.5	3.3	0.3	3.1	27
Toyota Yaris (2007)	3.6	3.4	0.3	3.9	32
Hyundai Accent (2007)	3.8	4.6	0.3	2.2	29
Chevy Aveo (2007)	4.4	4.5	0.3	2.8	37
Nissan Versa (2007)	5.0	3.9	2.6	2.5	28

Sport/Sporty Car

Mercedes CLK350 (2007)	1.7	0.5	0.6	0.0	20
Hyundai Tiburon (2007)	2.2	0.5	1.5	4.2	20
Porsche Cayman (2007)	2.4	0.7	2.4	0.0	23

Station Wagon

Volvo V50 (2007)	0.6	0.2	0.3	0.3	23
Pontiac Vibe (2007)	1.1	0.3	0.3	1.9	29
Suzuki SX4 (2007)	1.1	1.0	0.3	0.6	25
Volvo V70 (2007)	1.6	0.6	1.2	0.6	22
Kia Rondo (2007)	2.6	2.5	0.9	1.4	22
Mercedes E350 (2007)	3.0	0.2	2.6	2.5	19
Kia Rondo (2007)	3.1	2.2	1.2	3.1	22
Mazda Mazda 5 (2007)	3.2	2.8	0.6	1.9	22

Station Wagon

Acura RDX Tech (2007)	0.8	0.8	0.0	0.0	19
Jeep Compass (2007)	0.8	0.3	0.0	0.0	24
Jeep Wrangler (2007)	0.9	0.1	0.3	0.6	16
Hyundai Sante Fe (2007)	0.9	0.8	0.0	0.6	20
Chevy HHR (2007)	1.0	0.3	0.6	0.0	23
Chevy Equinox (2007)	1.1	0.1	0.6	0.0	19
GMC Acadia (2007)	1.3	0.3	1.2	0.0	19
Pontiac Torrent (2007)	1.3	0.5	0.6	0.0	20
Suzuki Grand Vitara (2007)	1.3	0.5	0.6	0.3	19
Buick Rendezvous (2007)	1.4	0.9	0.9	0.3	19
Lexus GX 470 (2007)	1.5	0.4	0.6	0.6	15
Mercury Mariner (2007)	1.7	1.0	0.3	2.5	21
Lincoln Lincoln MKX (2007)	1.8	0.2	1.5	0.3	19

Dodge Nitro (2007)	1.8	0.4	1.5	0.0	15
Mercedes R350 (2007)	1.9	0.3	0.9	0.0	16
Ford Edge (2007)	1.9	0.4	1.5	0.0	19
Lexus RX 350 (2007)	1.9	1.1	0.6	0.0	20
Hummer H3 (2007)	2.0	0.4	1.5	0.6	15
Hyundai Tuscon (2007)	2.0	1.2	0.6	2.5	20
BMW X3 3.0Si (2007)	2.0	0.9	1.5	0.0	20
Mazda CX-7 (2007)	2.0	0.4	1.5	0.0	19
Chevy Avalanche (2007)	2.1	0.6	1.8	0.0	16
Infiniti QX56 (2007)	2.1	0.8	0.9	0.6	14
Mercury Mountaineer (2007)	2.1	0.4	1.5	0.0	16
Nissan Armada (2007)	2.3	0.9	1.5	0.6	14
Volvo XC 90 (2007)	2.4	1.2	1.5	0.0	17
Chevy Suburban (2007)	2.5	2.0	1.2	0.3	16
Saturn Outlook (2007)	2.6	1.9	0.9	1.4	19
Subaru Outback (2007)	2.6	2.8	0.3	2.5	22
Lincoln Navigator (2007)	2.7	0.5	2.9	2.2	14
Dodge Durango (2007)	2.8	2.0	0.9	1.4	15
Audi Q7 (2007)	2.8	0.3	2.9	1.4	16
Ford Escape Hybrid (2007)	2.8	1.0	2.4	2.5	30
Buick Rainier (2007)	2.9	0.6	2.9	0.0	17
Cadillac Escalade (2007)	3.0	0.7	2.9	0.0	14

Saab 9-7x (2007)	3.0	0.6	2.9	0.6	16
Ford Expedition (2007)	3.0	2.1	1.5	0.8	15
Mercedes GL450 (2007)	3.2	0.6	2.9	0.0	15
Chrysler Aspen (2007)	3.2	0.6	3.5	0.6	15
Saturn VUE (2007)	3.2	2.2	1.8	1.4	22
Audi Q7 (2007)	3.3	0.6	3.2	3.6	16
Toyota FJ Cruiser (2007)	3.3	2.3	1.5	1.7	18
Subaru Forester (2007)	3.9	3.6	0.9	3.3	22

Upscale Sedan

Volvo S40 (2007)	1.0	0.2	0.9	0.0	23
Lexus IS 350 (2007)	1.0	0.4	0.0	0.0	21
Cadillac CTS (2007)	1.1	0.4	0.0	0.3	19
Infiniti G35 Sedan (2007)	1.5	0.5	0.3	0.3	20
Volvo S60 (2007)	1.6	0.4	1.2	0.0	21
Volvo S80 (2007)	2.0	0.3	1.5	0.6	19
Audi S4 (2007)	2.1	0.7	1.8	2.2	16
Lincoln MKZ (2007)	2.9	0.7	2.9	0.3	20
Mercedes C350 (2007)	3.2	0.5	2.6	0.0	21

2008 Model Year

	Overall Rating	Bromine	Chlorine	Lead	MPG-Combined
Convertible					
Porsche 911 (2008)	1.2	0.9	0.0	1.4	18
Mazda MX-5 (2008)	1.2	0.4	0.6	1.4	24
Chevy Corvette (2008)	1.3	0.0	1.2	0.0	18
Volvo C70 (2008)	1.7	0.4	1.5	0.0	21
Porsche Carrera (2008)	2.3	0.5	2.6	0.0	19
Chrysler Sebring (2008)	2.4	2.4	0.9	1.9	23
Audi A4 Cabriolet Quattro (2008)	3.1	0.4	3.2	0.6	22
BMW 328i (2008)	3.2	0.4	3.5	0.0	21
Audi TT Coupe Quattro (2008)	3.2	2.8	1.8	2.5	25
VW Beetle SE (2008)	3.9	0.5	4.4	1.4	23
BMW 128i (2008)	3.9	0.5	4.4	1.4	21

Coupe					
Mercedes CL550C (2008)	1.4	0.4	0.6	0.6	17
Infiniti G37 (2008)	1.4	0.2	0.9	0.0	20
Audi TT Coupe 2.0 (2008)	3.3	2.8	1.8	2.8	26

Family Sedan					
Honda Accord (2008)	0.8	0.3	0.0	0.0	25
Pontiac G6 (2008)	1.3	0.5	0.9	1.4	22
Hyundai Elantra (2008)	1.6	1.0	0.9	0.0	27
Chevy Malibu (2008)	1.6	0.0	1.5	1.4	20
Saturn Aura (2008)	1.7	0.5	0.9	1.4	20
Saturn Aura Hybrid (2008)	1.7	0.5	0.9	1.4	27
Nissan Altima (2008)	1.8	2.3	0.0	1.4	26
Ford Taurus (2008)	1.8	0.5	1.5	0.3	22
Toyota Camry (2008)	1.8	1.3	0.6	0.6	22
Mercury Sable (2008)	2.1	0.7	1.5	0.6	22
Ford Fusion (2008)	2.5	0.2	3.2	0.0	23
Dodge Avenger (2008)	2.8	2.4	0.9	1.9	24
VW Passat (2008)	2.8	0.1	3.2	1.4	22
Mercury Milan (2008)	2.8	0.3	3.2	0.0	23
Kia Optima (2008)	3.1	2.9	1.2	2.5	25
Kia Spectra (2008)	3.2	3.2	1.2	0.6	27
Mazda 6 (2008)	3.4	3.2	2.1	0.3	24

Large Sedan					
Dodge Charger (2008)	1.0	0.3	0.9	0.0	20
Pontiac G8 (2008)	1.0	0.2	0.6	0.0	20
Buick Lucerne (2008)	2.0	0.5	1.8	0.0	19
Mercury Grand Marquis (2008)	2.0	2.3	0.6	0.3	18
Chevy Impala (2008)	2.4	0.2	2.4	0.0	22
Chrysler 300 (2008)	2.6	0.4	2.9	0.0	18
Toyota Avalon (2008)	2.8	2.8	1.2	0.0	22

Luxury Sedan					
BMW M5 (2008)	0.8	0.5	0.0	0.0	13
Lexus LS 460 (2008)	1.1	0.6	0.0	0.6	19

Mercedes S550 (2008)	1.5	0.3	0.6	1.9	16
Infiniti M45 (2008)	1.6	1.0	0.6	0.0	19
Mercedes E63 (2008)	1.7	1.0	0.0	2.2	15
Lexus ES 350 (2008)	1.8	1.4	0.0	0.0	22
Lexus GS 460 (2008)	1.8	0.9	0.0	1.4	20
Mercedes CLS550 (2008)	1.8	0.3	0.6	1.9	16
Infiniti M35 (2008)	1.8	1.1	0.9	1.4	18
Lincoln Town Car (2008)	1.8	0.3	1.8	0.0	18
Audi A6 (2008)	2.8	0.6	3.2	0.0	21
Mercedes E320 (2008)	3.3	0.3	2.6	5.0	26
Mercedes E350 (2008)	3.4	0.2	2.6	4.7	18

Minivan					
Hyundai Entourage (2008)	1.3	0.6	0.6	0.8	18
Chrysler Town & Country (2008)	1.3	0.4	0.3	0.0	18
Honda Odyssey (2008)	1.4	0.6	0.6	0.0	18
Dodge Grand Caravan (2008)	1.8	2.0	0.3	2.8	18
Nissan Quest (2008)	2.0	0.4	1.8	0.0	19
Mazda 5 (2008)	2.7	3.1	0.6	2.2	23
Kia Sedona (2008)	3.0	3.0	0.9	3.1	18

Pickup Truck					
GMC Sierra 1500 (2008)	0.9	0.5	0.6	0.0	17
Toyota Tacoma (2008)	0.9	0.5	0.3	0.0	18
Honda Ridgeline (2008)	1.1	0.4	0.3	1.4	17
Chevy Colorado (2008)	1.1	0.3	0.3	0.0	20
Chevy Silverado (2008)	1.1	0.3	0.6	0.0	16
Nissan Titan (2008)	1.1	0.3	0.9	1.4	14
Chevy Silverado 2500 HD (2008)	1.2	0.8	0.3	0.3	16
Ford F-250 (2008)	2.1	2.2	0.6	1.4	
GMC Sierra 2500 (2008)	2.5	2.1	1.2	1.4	16
Dodge Dakota (2008)	2.6	1.8	1.5	1.4	15
Ford Ranger (2008)	3.0	2.7	2.1	0.0	21
Dodge RAM (2008)	3.0	2.2	2.1	1.4	15
Lincoln Mark LT (2008)	3.5	1.7	2.6	1.4	14

Small Car					
Smart Pure (2008)	0.6	0.1	0.0	0.0	32
Smart Passion Cabriolet (2008)	0.8	0.6	0.0	0.0	32
Chevy Cobalt (2008)	0.8	0.5	0.0	0.0	27
Smart Passion (2008)	0.9	0.3	0.6	0.0	32
Dodge Caliber (2008)	0.9	0.2	0.6	0.0	22
Saturn Astra XR 5dr (2008)	0.9	0.3	0.0	1.7	27
Honda Civic Hybrid (2008)	1.0	0.6	0.0	1.4	42
Saturn Astra XR (2008)	1.1	0.5	0.0	3.1	27
Suzuki SX4 Crossover (2008)	1.2	1.2	0.3	1.9	25
Subaru Impreza (2008)	1.3	0.5	0.9	0.0	22
Honda Civic (2008)	1.3	2.0	0.0	0.0	29
Volvo C30 (2008)	1.3	0.2	1.2	0.0	23
BMW Mini Cooper S Clubman (2008)	1.3	0.4	0.6	1.4	29
Nissan Versa (2008)	1.5	1.1	0.9	0.6	27
Nissan Sentra (2008)	1.7	0.5	1.5	0.0	28
Suzuki SX4 (2008)	1.7	2.6	0.0	0.0	25
VW Jetta (2008)	1.8	0.3	1.8	1.4	24
Hyundai Accent (2008)	2.2	2.7	0.3	0.8	29
Chevy Aveo (2008)	2.2	2.4	0.0	1.9	26

Mitsubishi Lancer (2008)	2.2	3.0	0.0	0.6	18
VW GTI (2008)	2.3	0.6	1.8	1.4	25
VW Rabbit (2008)	2.3	0.5	2.4	0.3	24
Kia Rio (2008)	2.3	2.8	0.3	0.8	29
Scion TC (2008)	2.7	2.7	0.6	1.9	23
VW R32 (2008)	2.8	0.6	2.9	0.6	20
Ford Focus (2008)	2.9	2.6	1.2	2.8	28
VW EOS (2008)	2.9	0.5	3.2	0.6	22
VW Beetle (2008)	3.5	0.4	4.4	0.0	23
Suzuki Forenza (2008)	3.5	3.7	1.8	0.0	22
Suzuki Reno (2008)	4.3	4.4	2.1	0.3	22

Sport/Sporty Car

Mercedes CLK350 (2008)	1.1	0.3	0.0	1.4	20
Porsche Boxster (2008)	1.1	0.5	0.0	1.4	23
Toyota Camry Solara (2008)	1.3	0.4	0.6	0.6	21
Mercedes SL550 (2008)	1.5	0.5	0.6	0.0	16
Mercedes SLK280 (2008)	1.7	0.3	0.6	2.2	20
Pontiac Solstice (2008)	1.8	0.2	1.5	0.0	22
Saturn Sky (2008)	2.1	0.1	1.8	1.4	22
Ford Mustang (2008)	2.3	2.4	0.9	1.4	20
Nissan 350Z (2008)	3.0	2.9	1.2	0.3	20

Station Wagon

Honda FIT (2008)	1.5	0.7	0.3	0.3	31
Suzuki SX4 Sport (2008)	1.7	2.6	0.0	0.0	26
Scion XB (2008)	2.2	2.7	0.3	1.4	24
Audi A3 (2008)	2.9	0.7	3.2	0.0	25
Kia Rondo (2008)	3.3	2.1	2.4	0.3	22

SUV

Acura RDX (2008)	0.6	0.4	0.0	1.4	19
Dodge Nitro (2008)	0.8	0.1	0.3	0.0	17
Chevy HHR (2008)	0.8	0.0	0.6	0.0	24
Dodge Journey (2008)	0.9	0.0	0.9	0.0	21
Honda Pilot (2008)	1.1	0.3	0.3	0.6	19
Pontiac Torrent (2008)	1.1	0.5	0.6	0.0	19
Subaru Tribeca (2008)	1.1	0.4	0.6	0.0	19
Honda CR-V (2008)	1.2	1.2	0.0	0.3	23
Nissan Armada (2008)	1.2	0.6	0.6	0.0	14
Nissan Frontier (2008)	1.2	0.4	0.9	0.0	16
Jeep Liberty (2008)	1.2	0.2	0.9	0.0	17
Lexus RX 350 (2008)	1.2	0.7	0.0	0.0	19
Volvo XC90 (2008)	1.2	0.3	0.9	0.6	15
Lexus GX 470 (2008)	1.3	0.8	0.6	0.0	15
Nissan Xterra (2008)	1.3	0.5	0.9	0.0	16
Infiniti FX35 (2008)	1.4	0.5	0.6	0.0	17
Ford Escape (2008)	1.4	0.4	1.2	0.0	20
Chevy Avalanche (2008)	1.5	0.2	1.2	0.6	16
Suzuki XL7 (2008)	1.5	0.3	0.9	0.3	18
Acura MDX (2008)	1.5	0.4	1.5	0.0	17
Nissan Pathfinder (2008)	1.5	0.5	0.9	0.3	16
GMC Yukon (2008)	1.6	0.1	1.5	0.0	14
Suzuki Grand Vitara (2008)	1.6	1.3	0.6	0.0	19
Saturn Outlook (2008)	1.6	0.0	1.5	1.4	19
Saturn Vue (2008)	1.6	1.3	0.0	1.4	18
GMC Yukon (2008)	1.6	0.5	1.2	0.0	16

Ford Edge (2008)	1.7	0.3	1.5	0.0	19
Infiniti EX35 (2008)	1.7	0.5	0.9	0.0	19
Mercury Mariner (2008)	1.7	0.4	1.2	0.0	22
Toyota Sequoia (2008)	1.7	0.4	1.2	0.0	15
Mazda CX-9 (2008)	1.8	0.5	1.5	0.0	18
VW Tiguan (2008)	1.8	0.4	1.8	1.1	21
Chevy Suburban (2008)	1.8	0.5	1.2	0.3	16
GMC Acadia (2008)	1.8	0.3	1.5	1.4	19
Infiniti QX56 (2008)	1.8	1.4	0.9	0.0	14
BMW X3 (2008)	1.8	0.5	1.5	0.0	20
Ford Taurus X (2008)	1.9	0.3	1.8	0.0	19
Toyota Sienna (2008)	1.9	2.0	0.9	0.0	18
Lincoln MKX (2008)	1.9	0.6	1.5	0.0	18
Mercury Mountaineer (2008)	1.9	0.5	1.5	0.0	16
Chevy Trailblazer (2008)	2.0	0.3	2.4	0.0	16
Jeep Compass (2008)	2.0	2.5	0.0	1.9	22
GMC Envoy (2008)	2.1	0.3	2.4	0.0	16
Mitsubishi Outlander (2008)	2.1	2.0	0.6	2.8	22
Jeep Wrangler (2008)	2.1	2.6	0.3	1.9	17
Mazda CX-7 (2008)	2.2	2.1	0.9	1.4	18
Volvo XC70 (2008)	2.2	0.5	1.5	1.4	17
Subaru Outback (2008)	2.2	2.7	0.3	1.4	22
Chrysler Aspen (2008)	2.2	0.2	2.4	0.0	15
Nissan Rogue (2008)	2.2	1.0	1.8	0.0	23
Honda Element (2008)	2.2	2.8	0.3	0.0	22
Jeep Grand Cherokee (2008)	2.2	2.0	0.9	0.6	17
Toyota Highlander Hybrid (2008)	2.2	2.0	0.9	0.6	26
Mercedes ML350 (2008)	2.3	1.1	1.5	1.9	17
Ford Explorer (2008)	2.5	0.2	2.9	0.6	15
Toyota FJ Cruiser (2008)	2.5	1.9	1.5	1.4	17
VW Touareg (2008)	2.5	0.4	2.9	0.3	17
Chevy Tahoe (2008)	2.6	0.4	2.9	0.0	16
Jeep Commander (2008)	2.6	2.6	0.9	0.0	16
Kia Sportage (2008)	2.6	2.0	1.2	3.9	21
Chrysler Pacifica (2008)	2.7	0.4	2.9	0.0	17
Toyota 4Runner (2008)	2.8	2.8	0.9	1.4	17
Mercedes GL450 (2008)	2.8	0.3	2.9	1.7	15
Hyundai Veracruz (2008)	2.9	2.9	0.6	1.1	18
Porsche Cayenne (2008)	3.0	0.3	3.2	0.0	16
Kia Sorento (2008)	3.2	2.7	1.2	3.1	18
Mercedes R350 (2008)	3.2	0.3	2.9	2.2	16
BMW X5 (2008)	3.3	0.7	3.2	0.3	16
Lincoln Navigator (2008)	3.3	1.7	2.9	0.0	14

Upscale Sedan

Volvo S40 (2008)	1.0	0.4	0.3	1.9	21
Infiniti G35 (2008)	1.2	0.1	0.9	0.0	19
Lexus IS 250 (2008)	1.3	0.8	0.0	1.4	22
Lexus IS 350 (2008)	1.3	0.8	0.0	1.4	20
BMW 335xi (2008)	1.3	0.8	0.0	0.0	20
Acura TL (2008)	1.5	0.7	1.2	0.6	21
Volvo S60 (2008)	1.6	0.4	1.2	0.6	22
Volvo S80 (2008)	1.9	0.6	1.5	0.0	19
Lincoln MKZ (2008)	2.7	0.3	2.9	0.0	22
Audi A4 Quattro Sedan (2008)	3.0	0.4	3.2	1.4	24
Mercedes C300 (2008)	3.0	0.4	2.6	2.8	20
BMW 335i (2008)	3.2	0.4	2.9	1.9	20

Mercedes C350 (2008)	3.2	0.7	2.6	2.8	20
Van					
Ford E-150 Van (2008)	1.8	0.5	2.1	0.0	

Hyundai Sonata SEV6 (2009)	1.1	0.6	0.3	0.0	22
Hyundai Sonata GLS (2009)	1.4	0.7	0.3	1.1	25
Toyota Camry (2009)	2.0	2.3	0.6	1.4	25
Subaru Legacy (2009)	2.3	2.7	0.3	1.4	22
Mitsubishi Galant (2009)	2.6	0.9	2.9	0.6	23

Small Car					
Toyota Matrix (2009)	1.7	1.9	0.0	0.6	28

Station Wagon					
Pontiac Vibe (2009)	1.7	1.9	0.3	1.4	29

SUV					
Nissan Murano (2009)	1.6	0.6	0.9	1.4	20
Subaru Forester (2009)	2.4	2.8	0.3	1.9	22

Upscale Sedan					
Acura TSX (2009)	0.9	0.7	0.0	0.0	25

	Overall Rating	Bromine	Chlorine	Lead	MPG-Combined
2009 Model Year					
Convertible					
Mitsubishi Eclipse (2009)	4.7	4.4	2.4	0.6	19
Family Sedan					

APPENDIX: UNDERSTANDING THE VEHICLE RATINGS

The www.HealthyCar.Org vehicle rating system was developed in order to provide a means for consumers to compare the relative concern associated with materials in new model vehicles. The following section provides an overview of the method used to determine the vehicle ratings.

SELECTING THE CHEMICALS OF CONCERN

HealthCar.org rates vehicles based on the detection and concentrations of the following elements or chemical compounds containing these elements: Antimony, Arsenic, Bromine, Chlorine, Chromium, Cobalt, Copper, Lead, Mercury, Nickel, Tin. These elements or compounds were chosen for the following reasons.

1. **They could be easily and quickly identified using non-destructive methods.** Sampling for this project was limited to new vehicles, thus testing could not damage the vehicle. The XRF device was used to sample each component for the presence of 38 elements as percent by weight or parts per million (ppm). The reporting of 27 of these elements was eliminated on the basis of non-occurrence or low concern, leaving the 11 elements mentioned above.
2. **These elements, and the chemical(s) associated with them in vehicle applications, have been subject to either regulatory restrictions and/or voluntary limits set by industry associations or third party certification organizations.** These elements and their chemical compounds have been associated with health and environmental concerns in the range of the concentrations detected in the sampling conducted for this study. A wide-range of regulatory and voluntary limits for elements in products were reviewed for this study. A summary of the standards reviewed for toys, paints,

vehicles, electronics and packaging is included in Table A1 on the next page.

Two voluntary certification standards are currently being used by Volvo⁷² and Ford⁷³ to certify vehicles for air quality and allergen-free content: the Oeko-Tex 100 and TÜV standards. Ford certifies vehicles using the TÜV Rheinland Group's TOXPROOF Certification (including the SG textiles standard)⁷⁴. To date, four of Ford's European model vehicles have been certified, including the Focus, Focus C-MAX, Ka and Galaxy⁷⁵. Volvo has certified all of its vehicle interiors to the Oeko-Tex Standard 100^{76,77}. Two other standards for plastic and fabric in other types of products are also highlighted. Since the 1980's TCO Development in Sweden has developed standards for information technology equipment for ease of use and environmental considerations. The TCO'05 Desktop Computer and Work Chairs Standard is one of the more

⁷² Volvo Cars.

<http://www.volvocars.com/corporation/environment/CleanInside.htm> (Accessed 03/09/07).

⁷³ TÜV Rheinland. 2007. "First Allergy Label for Car Buyers."

http://www.tuv.com/de/en/news_first_allergy_label_for_car_buyers.html (Accessed 03/09/07).

⁷⁴ TÜV Rheinland. 2007.

<http://www.tuvdotcom.com/pi/web/TuvdotcomIdSearchResults.xml?TUVdotCOMID=4111008300&LanguageChange=d=en-us> (Accessed 03/01/07)

⁷⁵ TÜV Rheinland. 2007. "First Allergy Label for Car Buyers."

http://www.tuv.com/de/en/news_first_allergy_label_for_car_buyers.html (Accessed 03/09/07).

⁷⁶ Volvo Cars.

<http://www.volvocars.com/corporation/environment/CleanInside.htm> (Accessed 03/09/07).

⁷⁷ Volvo Cars.

<http://www.volvocars.com/corporation/FactsandFigures/EnvironmentalProductInformationEurope/incar.htm> (Accessed 03/09/07).

comprehensive and restrictive standards available. The Nordic Swan label for computers also limits the presence of many groups of chemicals, including halogens, in plastic components. The elemental limits for all of these standards are listed in Table A1.

Due to the current use of the Oeko-Tex & TÜV standards within the auto industry, the elemental limits in these standards were used as a baseline for evaluating the health of the inside vehicle environment. While the elemental limits in these standards are based on the amount of extractable metals from a homogeneous material, the XRF measures elemental composition of materials as percent by weight and averages measurements between different layers of a heterogeneous material (e.g. fabric

covers the seat foam). In general, the amount of metals extractable from materials is typically less than the actual content of the material.

The XRF results were considered to be relevant because the levels typically observed in cars significantly exceeded guideline limits cited in Table A1. The XRF also underestimates actual levels of elements in heterogeneous materials due to the averaging of different layers of the material. Most materials in this study were multi-layer materials. XRF results *greater than* the instrument detection limit in general exceed the levels outlined in Table A1.

Table A1: Samples of Product Standards and Elemental Limits

	Oeko-Tex 100	TUV	Nordic Swan⁴	TCO⁸
<i>PRODUCTS</i>	<i>Fabrics and Leather</i>	<i>Cars and Fabrics</i>	<i>Computers</i>	<i>Computers and Work Chairs</i>
ELEMENTS	"SAFE" LIMITS			
Antimony	30 ppm	2 ppm		
Arsenic	1 ppm	0.2 ppm	None, Leathers	
Bromine	No BFRs ¹	Non Detect	No BFRs ⁶	No BFRs ⁹
Chlorine			No PVC/ No Cl FRs ⁵	No PVC NoClFRs ⁹
Chromium	2 ppm	2 ppm ² / 200/50 ppm ³	3 ppm ⁷	
Cobalt	4 ppm	4 ppm		
Copper (organic)	50 ppm	60 ppm		
Lead	1 ppm	0.8 ppm	1,000 ppm	None
Mercury	0.02 ppm	.02 ppm	1,000 ppm	None
Nickel	4.0 ppm	4 ppm		
Tin (organic)	1 ppm	Non Detect		
TEST METHOD	Extractable	Extractable	By weight	By weight

¹ BFR includes: PBB, TRIS, TEPA, pentaBDE, octaBDE. A list of approved flame retardant materials are listed on Oeko Tex web site.

² Chromium (VI)

³ Total Chromium content. 200 ppm adults/50 ppm children

⁴ Available at: <http://www.svanen.nu/Eng/products/> (Accessed on 03/02/07).

⁵ No PVC in housing and chassis. No chlorinated flame retardants.

⁶ No BFRs. Exemption for printed wiring boards and plastic parts weighing less than 25g. These parts must not, however, contain any PBB (polybrominated biphenyls), PBDE (polybrominated diphenyl ethers) or chlorinated paraffins (maximum allowable concentration for impurities is 0.1 % by weight in homogenous material).

⁷ Chromium (VI)

⁸ Available at: <http://www.tcodevelopment.com/> (Accessed on 03/02/07)

⁹ Plastic parts weighing more than 25 grams shall not contain flame retardants that include organically bound bromine or chlorine. Exempted are printed wiring board laminates, electronic components and all kinds of cable insulation. Plastic parts weighing more than 25 grams shall not contain chlorine or bromine as a part of the polymer. Parts containing other materials in any significant amounts, e.g. cables with their metal conductors, are not included in the requirements.

VEHICLE SAMPLING

The primary purpose of testing individual components in vehicles was to establish the presence and relative abundance of chemicals of concern.

A total of 11 components from each vehicle were selected for sampling. The components were selected based on the following criteria:

- Potential of exposure, i.e. components that drivers or passengers come in contact with, that are subject to abrasion, or that otherwise release vapors or particles to the environment;
- Surface area and relative size of component;
- Potential to off-gas or degrade during heat and/or UV-ray exposure;
- Ease of access to component for sampling.

Components sampled included:

Armrest/Center Console
Carpet
Dashboard
Door Trim (hard)
Door Trim (soft)
Front Seat (front side)
Front Seat (back side)
Headliner
Seat Base
Shift Knob
Steering Wheel

Non-destructive sampling was conducted on vehicle components using X-ray Fluorescence (XRF) spectrometry. XRF spectrometry is used to identify elements in a substance and quantify the amount of those elements present. Hand-held, portable XRF devices are now commonly used in many industrial settings to verify material quality and assure adherence to composition specifications.

XRF devices use the following process to determine the composition of materials:

1. An x-ray tube emits high-energy x-ray

photons that strike the sample being analyzed.

2. These photons knock electrons in each atom from the innermost orbitals of some atoms in the sample, making the atoms unstable.
3. As electrons move from outer orbitals to the vacant space closer to the nucleus of the atom, they emit energy in a secondary x-ray photon; this is known as fluorescence.
4. The analyzer measures the amount of energy in the x-rays emitted by the atoms in the sample material as they return to their original state, an energy that is characteristic of each element.
5. The analyzer quantifies this energy and makes a conversion to report whether an element is present and in what concentration.

When in use, the analyzer emits radiation from the exit port (the front of the instrument). Radiation levels at the port are approximately 28,000 millirems per hour in the direct x-ray beam, and 2,000 millirems per hour 4 inches away. To put these numbers in perspective, a chest x-ray provides a dose of 100 millirems; 5,000 millirems total per year are considered acceptable for a non-pregnant adult. The radiation level for the operator is less than 0.1 millirems per hour. The analyzer does not emit radiation when it is not in use. When it is emitting radiation during a test, the red light on the top of the analyzer blinks. The XRF Analyzer is manufactured by Innov-X Systems, Inc., located in Woburn, Massachusetts. More information about the analyzer and the company may be found at www.innov-xsys.com.

Each component was sampled for 15 seconds. Components were sampled at similar locations in each vehicle. Detection limit guidelines were provided by the XRF manufacturer. (Detection limits are estimates based on 1-2 minute test times and detection confidence of 3-sigma, or 99.7% confidence.) Detection limit guidelines and lowest observed detection limits are presented in Table A2. Observed detection limits were consistent with manufacturers guidelines.

The XRF sampler also automatically calculates a 1-sigma (68.2%) error margin for each sample. A sample of the test data showing detected level in ppm and +/- one-sigma error margin is shown in Table A3. To ensure that our readings were accurate, we performed a quality analysis on several samples. In this analysis, we tested the same

component at multiple points in two vehicle models, the Subaru Legacy and the Nissan Versa. In addition, repeat samples were collected from identical vehicles to look for variation between vehicles. The results of these samples are shown in Table A4 and Table A6 on the next pages. In all cases, we found adequate consistency in detection levels at different locations in the same component and the same components tested in identical vehicles.

XRF measures surfaces up to a depth of 6–12 mm and provides quantitative values for specific elements within the matrix of a given test object. For homogeneous materials, the results are expected to reflect the actual concentration of the measured element. However, since components like seats or headliners are usually composed of several layers of different materials, the XRF results are an average of all materials up to the depth of X-Ray penetration. For example, the XRF reading for bromine levels in a seat will be composed of the foam, the fabric or

Table A2: XRF Detection Limits

ELEMENT	Manufacturers Detection Limits¹	Observed Detection Limits (30 second sample)²
Antimony	50-150 ppm	109 ppm
Arsenic	10-100 ppm	1 ppm
Bromine	10-100 ppm	2 ppm
Chlorine	1%-5%	2.80%
Chromium	10-100 ppm	39 ppm
Cobalt	10-100 ppm	37 ppm
Copper	10-100 ppm	38 ppm
Lead	10-100 ppm	5 ppm
Mercury	10-100 ppm	7 ppm
Nickel	10-100 ppm	27 ppm
Tin	50-150 ppm	130 ppm

¹ InnovX Model ABC XRF Detector detection estimates based on 1-2 minute test times and detection confidence of 3-sigma, or 99.7% confidence. Detection limits are a function of testing time, sample matrix and presence of interfering elements.

² Observed detection limits varied by type of material being tested. Detection limits presented here are the lowest observed from all testing.

Table A3: Sample Data for Door trim (soft), Cl and Br error margins (ppm)

MAKE	MODEL	SPECS	MARKET CLASS	YEAR	CHLORINE	Cl (1-sigma +/-)	BROMINE	Br (1-sigma +/-)
Chrysler	Town & Country	LTD	Minivan	2006	247,636	10,424	0	4
VW	Jetta	-	Small Car	2006	183,186	8,736	0	4
Buick	Lucerne	CXL	Large Sedan	2007	157,568	7,659	3	1
Audi	Q7	-	SUV	2007	175,511	8,534	4	1
VW	Touareg	V8	SUV	2006	170,562	8,181	0	3
GMC	Yukon	Denali	SUV	2006	141,634	8,001	2,500	35
Saturn	Sky	-	Convertible	2007	163,789	9,607	0	4
Mercedes	GL450	4matic	SUV	2007	204,440	9,236	0	4
Cadillac	DTS	4.6L V8	Luxury Sedan	2007	134,341	7,362	26	2
Buick	Terraza	CXL 1SD	Minivan	2007	121,029	7,504	791	13
Saturn	Relay	AWD RF3	Minivan	2006	153,625	7,867	0	4
Audi	A6 Avanti	3.2	Luxury Sedan	2006	175,068	8,707	17	2

leather seat covering, and any fabric backing as shown in Table A5. Therefore, the seat foam alone may have a higher bromine level, but the reading will be lower due to the presence of the fabric and back

coating, or vice versa. This type of averaging results in *lower* levels being reported in heterogeneous samples. Most samples used in this study are considered heterogeneous samples.

Table A4: Repeat Sample Data, Components

Note: <LOD, Level of Detection; levels in ppm

SUBARU LEGACY: Element detection levels (ppm)

COMPONENT	Cl	Cl +/-	Br	Br +/-	Sb	Sb +/-	Pb	Pb +/-	Cr	Cr +/-
Steering Wheel	<LOD	11,160	7	1	<LOD	125	<LOD	5	<LOD	36
Steering Wheel	<LOD	12,139	6	1	<LOD	130	<LOD	5	<LOD	37
Steering Wheel	<LOD	12,981	8	1	<LOD	139	<LOD	5	<LOD	40
Dashboard	<LOD	12,375	9	1	<LOD	133	<LOD	6	<LOD	46
Dashboard	<LOD	12,692	10	1	<LOD	134	<LOD	6	<LOD	43
Dashboard	<LOD	13,383	11	1	<LOD	143	<LOD	6	<LOD	48
Headliner	<LOD	23,444	11	2	<LOD	220	<LOD	12	<LOD	98
Headliner	<LOD	19,856	8	2	<LOD	208	<LOD	9	<LOD	73
Headliner	<LOD	22,590	13	2	<LOD	218	<LOD	12	<LOD	89
Seat Front	<LOD	16,443	<LOD	3	<LOD	175	14	3	<LOD	59
Seat Front	<LOD	17,072	<LOD	3	<LOD	182	<LOD	8	<LOD	66
Seat Front	<LOD	18,561	<LOD	3	<LOD	193	<LOD	8	<LOD	69
Exterior Window Seal	303,078	12,526	<LOD	5	<LOD	159	<LOD	12	<LOD	153
Exterior Window Seal	258,969	11,484	<LOD	5	<LOD	168	<LOD	9	<LOD	140
Exterior Window Seal	277,308	12,366	<LOD	5	<LOD	166	<LOD	11	<LOD	128

NISSAN VERSA: Element detection levels (ppm)

COMPONENT	Cl	Cl +/-	Br	Br +/-	Sb	Sb +/-	Pb	Pb +/-	Cr	Cr +/-
Armrest/Center Console	116,232	8,766	<LOD	4	2,866	81	<LOD	9	<LOD	92
Armrest/Center Console	112,203	8,793	<LOD	4	2,855	83	<LOD	9	<LOD	94
Armrest/Center Console	100,292	8,086	<LOD	3	2,685	76	<LOD	8	<LOD	78
Seat Front	<LOD	36,809	34,098	835	7,761	255	139	11	492	58
Seat Front	<LOD	34,375	32,146	764	7,577	242	156	11	626	65
Seat Front	<LOD	31,505	25,283	550	5,964	190	115	9	431	51
Hard Door Trim	<LOD	13,921	<LOD	3	<LOD	146	<LOD	7	128	25
Hard Door Trim	<LOD	15,796	<LOD	2	<LOD	158	<LOD	7	146	29
Hard Door Trim	<LOD	14,302	<LOD	3	<LOD	153	<LOD	8	131	26
Soft Door Trim	112,451	6,485	53	2	1,566	55	9	3	<LOD	62
Soft Door Trim	282,862	13,035	203	7	3,523	92	48	7	<LOD	158
Soft Door Trim	136,685	7,748	65	3	2,012	62	16	3	<LOD	76
Exterior Window Seal	471,785	20,375	<LOD	11	<LOD	162	<LOD	24	<LOD	374
Exterior Window Seal	547,122	22,473	<LOD	12	<LOD	154	<LOD	28	939	205
Exterior Window Seal	550,000	23,843	<LOD	12	<LOD	158	31	10	735	204

Table A5: XRF Averaging of Heterogeneous Samples¹

VEHICLE	COMPONENT	BROMINE
1996 Dodge Neon	Full Seat (Cloth)	21,300 ppm
	Seat Foam Only	89 ppm
	Fabric Only - outer surface	62,400 ppm
	Fabric Only - inner surface	77,400 ppm
1993 Mercury Grand Marquis	Full Seat (PVC)	87 ppm
	Seat Foam Only	8 ppm
	Fabric/PVC - outer surface	192 ppm
	Fabric/PVC - inner surface	34 ppm
1998 Oldsmobile Silhouette	Full Seat (Leather)	4,181 ppm
	Foam Only	10,100 ppm
	Leather - outer surface	2,780 ppm
	Leather - inner surface	2,564 ppm

¹ Seat coverings (cloth, PVC or leather) were removed from foam and analyzed from the outer and inner surface of the material. "Full seat" reading is taken with seat assembly intact and is typical of samples used in this study. "Foam only" sample is for seat foam that has been sliced in half to give a foam only sample.

Table A6: Repeat Sample Data, Vehicles & Components

Note: <LOD, Level of Detection; Levels in ppm

b +/-

2008 Honda Civic	Arm rest/center console	<LOD	12,921	<LOD	47	<LOD	32	5	1	<LOD	142
2008 Honda Civic Hybrid	Arm rest/center console	<LOD	12,767	<LOD	41	<LOD	31	14	1	<LOD	143
2008 Honda Civic	Carpet	<LOD	17,115	<LOD	59	955	48	5,206	76	<LOD	176
2008 Honda Civic Hybrid	Carpet	<LOD	29,646	<LOD	106	161	52	26	3	<LOD	289
2008 Honda Civic	Door trim (hard)	<LOD	15,210	<LOD	70	<LOD	153	39	2	<LOD	160
2008 Honda Civic Hybrid	Door trim (hard)	<LOD	16,721	<LOD	64	<LOD	144	37	2	<LOD	159
2008 Honda Civic	Door trim (soft)	<LOD	13,686	<LOD	50	<LOD	28	4	1	<LOD	152
2008 Honda Civic Hybrid	Door trim (soft)	<LOD	12,926	<LOD	41	<LOD	36	<LOD	2	<LOD	139
2008 Honda Civic	Front seat (front)	<LOD	22,117	<LOD	85	<LOD	53	<LOD	4	<LOD	226
2008 Honda Civic Hybrid	Front seat (front)	<LOD	18,383	<LOD	60	<LOD	42	7	1	<LOD	191
2008 Honda Civic	Front seat (rear)	<LOD	20,156	<LOD	68	<LOD	105	<LOD	3	<LOD	197
2008 Honda Civic Hybrid	Front seat (rear)	<LOD	18,996	<LOD	112	3,254	165	7	1	<LOD	195
2008 Honda Civic	Headliner	<LOD	22,886	<LOD	90	745	74	33	3	<LOD	227
2008 Honda Civic Hybrid	Headliner	<LOD	23,998	<LOD	110	1,395	148	20	3	<LOD	243
2008 Honda Civic	IP	<LOD	12,734	<LOD	41	<LOD	75	<LOD	2	<LOD	134
2008 Honda Civic Hybrid	IP	<LOD	12,859	<LOD	56	<LOD	113	<LOD	2	141	46
2008 Honda Civic	Seat base	<LOD	12,670	86	20	<LOD	60	<LOD	2	<LOD	136
2008 Honda Civic Hybrid	Seat base	<LOD	12,624	187	24	<LOD	56	<LOD	2	235	46
2008 Honda Civic	Shift Knob	<LOD	13,906	<LOD	41	<LOD	27	13	1	<LOD	148
2008 Honda Civic Hybrid	Shift Knob	<LOD	14,798	<LOD	42	<LOD	26	11	1	<LOD	154
2008 Honda Civic	Steering wheel	<LOD	12,615	<LOD	40	<LOD	55	<LOD	2	<LOD	136
2008 Honda Civic Hybrid	Steering wheel	<LOD	12,555	<LOD	37	<LOD	64	<LOD	2	<LOD	136

Vehicle	Component/Test Area	Cl	Cl +/-	Cr	Cr +/-	Co	Co +/-	Br	Br +/-	Sb	Sb +/-
2007 Toyota Tundra	Arm rest/center console	211,304	11,794	<LOD	111	<LOD	65	<LOD	5	1,671	74
2007 Toyota Tundra CMAX	Arm rest/center console	178,825	11,421	<LOD	121	<LOD	116	<LOD	5	1,179	73
2007 Toyota Tundra	Carpet	<LOD	18,542	<LOD	53	<LOD	46	423	9	213	61
2007 Toyota Tundra CMAX	Carpet	<LOD	20,339	<LOD	67	<LOD	115	30	3	251	70
2007 Toyota Tundra	Door trim (hard)	<LOD	14,885	<LOD	55	<LOD	91	<LOD	3	<LOD	162
2007 Toyota Tundra CMAX	Door trim (hard)	<LOD	19,219	<LOD	82	<LOD	190	<LOD	3	<LOD	201
2007 Toyota Tundra	Door trim (soft)	150,137	11,368	<LOD	112	<LOD	46	<LOD	4	6,310	141
2007 Toyota Tundra CMAX	Door trim (soft)	145,232	11,743	<LOD	95	<LOD	75	<LOD	5	6,279	152
2007 Toyota Tundra	Front seat (front)	<LOD	33,177	<LOD	160	<LOD	129	23,194	541	4,492	176
2007 Toyota Tundra CMAX	Front seat (front)	<LOD	33,958	<LOD	148	<LOD	124	24,537	571	4,533	178
2007 Toyota Tundra	Front seat (rear)	<LOD	29,636	<LOD	133	717	163	17	3	<LOD	272
2007 Toyota Tundra CMAX	Front seat (rear)	<LOD	24,121	<LOD	97	<LOD	115	668	18	<LOD	249
2007 Toyota Tundra	Headliner	<LOD	27,130	<LOD	88	<LOD	119	<LOD	5	<LOD	259
2007 Toyota Tundra CMAX	Headliner	<LOD	35,526	<LOD	120	419	78	10	3	<LOD	329
2007 Toyota Tundra	IP	<LOD	14,108	<LOD	105	<LOD	56	<LOD	2	<LOD	146
2007 Toyota Tundra CMAX	IP	<LOD	19,736	<LOD	150	<LOD	169	<LOD	3	<LOD	204
2007 Toyota Tundra	Seat base	<LOD	17,337	<LOD	56	<LOD	46	9	2	<LOD	190
2007 Toyota Tundra CMAX	Seat base	<LOD	18,557	<LOD	74	<LOD	124	<LOD	4	<LOD	192
2007 Toyota Tundra	Shift Knob	200,656	14,634	<LOD	164	<LOD	56	<LOD	6	<LOD	252
2007 Toyota Tundra CMAX	Shift Knob	188,372	13,832	<LOD	144	<LOD	69	<LOD	5	308	82
2007 Toyota Tundra	Steering wheel	<LOD	13,039	<LOD	40	<LOD	37	23	1	<LOD	142
2007 Toyota Tundra CMAX	Steering wheel	<LOD	19,479	<LOD	69	<LOD	169	<LOD	4	<LOD	219

Vehicle	Component/Test Area	Cl	Cl +/-	Cr	Cr +/-	Co	Co +/-	Br	Br +/-	Sb	Sb +/-
2008 VW Beetle Vehicle #1	Arm rest/center console	101,513	6,870	<LOD	58	<LOD	62	<LOD	3	1,165	58
2008 VW Beetle Vehicle #2	Arm rest/center console	150,616	7,960	<LOD	77	<LOD	64	<LOD	3	1,284	57
2008 VW Beetle Vehicle #1	Carpet	<LOD	18,152	<LOD	59	<LOD	64	14	2	<LOD	193
2008 VW Beetle Vehicle #2	Carpet	<LOD	21,325	95	30	<LOD	63	<LOD	4	<LOD	213
2008 VW Beetle Vehicle #1	Door trim (hard)	<LOD	13,672	101	26	499	33	<LOD	2	282	49
2008 VW Beetle Vehicle #2	Door trim (hard)	<LOD	11,517	<LOD	33	<LOD	34	92	3	<LOD	126
2008 VW Beetle Vehicle #1	Door trim (soft)	211,109	10,347	<LOD	138	<LOD	120	<LOD	4	2,453	75
2008 VW Beetle Vehicle #2	Door trim (soft)	215,988	10,006	<LOD	88	<LOD	40	<LOD	4	2,320	71
2008 VW Beetle Vehicle #1	Front seat (front)	271,112	11,606	<LOD	154	<LOD	103	<LOD	6	2,478	74
2008 VW Beetle Vehicle #2	Front seat (front)	238,717	10,727	<LOD	98	<LOD	64	9	2	1,721	65
2008 VW Beetle Vehicle #1	Front seat (rear)	303,739	13,328	<LOD	188	131	42	<LOD	6	2,194	73
2008 VW Beetle Vehicle #2	Front seat (rear)	287,105	12,518	<LOD	139	121	29	7	2	1,925	69
2008 VW Beetle Vehicle #1	Headliner	<LOD	25,023	<LOD	117	<LOD	76	248	9	2,807	122
2008 VW Beetle Vehicle #2	Headliner	<LOD	24,187	<LOD	113	<LOD	74	285	9	1,942	105
2008 VW Beetle Vehicle #1	IP	223,956	10,801	<LOD	103	<LOD	33	8	2	<LOD	152
2008 VW Beetle Vehicle #2	IP	233,359	10,215	<LOD	102	<LOD	37	6	2	<LOD	147
2008 VW Beetle Vehicle #2	Other	<LOD	23,190	178	52	<LOD	173	21	2	954	82
2008 VW Beetle Vehicle #2	Sealer (trunk)	<LOD	34,340	<LOD	172	<LOD	75	<LOD	6	<LOD	267
2008 VW Beetle Vehicle #1	Seat base	<LOD	15,634	3,432	111	<LOD	84	<LOD	3	<LOD	168
2008 VW Beetle Vehicle #2	Seat base	<LOD	14,128	<LOD	45	133	29	4	1	<LOD	150
2008 VW Beetle Vehicle #1	Shift Knob	<LOD	12,000	<LOD	37	<LOD	36	<LOD	2	<LOD	133
2008 VW Beetle Vehicle #2	Shift Knob	<LOD	12,012	<LOD	41	<LOD	38	<LOD	2	<LOD	135
2008 VW Beetle Vehicle #1	Steering wheel	<LOD	14,070	75	18	<LOD	31	<LOD	2	<LOD	151
2008 VW Beetle Vehicle #2	Steering wheel	<LOD	14,251	<LOD	47	<LOD	48	<LOD	2	<LOD	150

ESTABLISHING THE RELATIVE LEVELS OF CONCERN

Vehicle ratings were calculated based on the XRF results from the 12 vehicle components that were tested on all vehicles. Wheel weights, sealers, and wiring were not sampled in every vehicle and thus were not included in the ratings.

The rating for each vehicle was determined using the following process:

1. Each component was given a weighting based on its relative size and potential to release chemicals or dust. This weighting was based on judgment on the part of the researchers. The component weighting factor for each component is indicated in Table A7.
2. Each element was given a chemical weighting factor (multiplier) based on the level of concern associated with it and its related chemical compounds, as well as the concentration level detected. Higher concentrations were assigned higher weights. For instance, there were 2 levels of concern determined for bromine depending on the concentration that was detected. The weighting for each element and for different concentrations of elements is shown in Table A8. Explanation of the relative weight of each element is

Table A7: Relative Weighting of Each Component

COMPONENT	WEIGHT
Armrest/Center Console	1
Carpet	5
Dashboard	5
Hard Door Trim	1
Headliner	2
Seat Back	1
Seat Base	5
Seat Front	2
Shift Knob	2
Soft Door Trim	1
Steering Wheel	1

provided below.

Bromine: Bromine indicates the likely presence of a brominated flame retardant (BFR). BFRs, particularly decabrominated diphenylethers (deca), have been found in dust and windshield film samples from new model vehicles. Deca may degrade into more toxic chemicals when exposed to heat and UV radiation. We therefore consider bromine a relatively high-concern substance when present at higher concentrations. We thus assigned it a relative weight of 10 for concentrations above 1,000 ppm. Concentrations lower than 1,000 ppm received a weight of 1.

Chlorine: All chlorine detected was in concentrations higher than 10,000 ppm, which indicates the likely presence of PVC. We cannot, however, rule out the possibility of other chlorinated compounds, like flame retardants, being present in the materials. PVC has been identified as a problem chemical throughout its lifecycle. Formation of highly toxic dioxins and furans during combustion and evaporation in production and end of life, as well as release of phthalates from soft PVC materials are of particular concern. Considering the likely possibility that chlorine indicates the use of PVC and

Table A8: Elements Detected and their Relative Weight in the Ratings
<LOD = Level of Detection

ELEMENT	WEIGHT
Bromine (low)	1 (>LOD, <1,000 ppm)
Bromine (high)	10 (>1,000 ppm)
Chlorine	10 (> 10,000ppm)
Lead (low)	1 (>LOD, <600 ppm)
Lead (high)	5 (>600 ppm)
Antimony	1 (>LOD)
Arsenic	1 (>LOD)
Chromium	1 (>LOD)
Cobalt	1 (>LOD)
Copper	1 (>LOD)
Nickel	1 (>LOD)
Mercury	1 (>LOD)
Tin	1 (>LOD)

phthalates additives, we regard chlorine as a relatively high-concern substance and assigned it a relative weight of 10.

Lead: The link between lead and serious developmental and other health concerns is well established. The toy industry restricts the use of lead in concentrations higher than 600 ppm. We therefore assigned a relative weight of 5 to lead concentrations above 600 ppm, and a relative weight of 1 to lower concentrations.

The remaining elements were also found in vehicle components and are associated with harmful health effects even at relatively low concentrations. Some of them are carcinogens, others are allergens or heavy metals. Concentrations of these substances were mostly found at lower levels than the above-mentioned substances, and thus we consider them to have a comparatively low health concern, and assigned them each a relative weight of 1.

3. The component weight factor was multiplied by the chemical (and concentration) weight factor to produce points. The shaded area in Table A9 shows the resulting points.

4. The points for each of the 12 components were added to produce chemical scores for bromine, chlorine, lead and other chemicals. In order to communicate the relative concern to the public, these scores were then scaled on a 0-5 basis, with 5 being the highest concern and 0 being the lowest. These 0-5 scores are referred to as the *chemical ratings*.
5. The total scores for all the chemicals were added to produce an overall score that indicates the relative concern of the complete vehicle. This score was then scaled on a 0-5 basis with 5 being the highest concern and 0 being the lowest. This scaled score is referred to as the *overall vehicle rating*. It allows consumers to identify vehicles of lower concern.
6. Finally, the general categories of concern were established. This was done by ranking the *overall vehicle rating* for all 209 vehicles sampled as part of the HealthyCar.org sample set, and assigning relative *low concern* to vehicles in the 0-15th percentile; relative *medium concern* to vehicles between the 15th to 85th percentile; and relative *high concern* to vehicles above the 85th percentile. The 15th and 85th percentile values established in the 2007 sample set have been used to evaluate all subsequently sampled vehicles. HealthyCar.org 2008 vehicles are evaluated in relation to previously sampled vehicles.

Table A9: Final Points Used for Vehicle Ratings

COMPONENT	PPMs	BROMINE		CHLORINE	LEAD		OTHER*
		>LOD & <1000	>1000	>10,000	>LOD & <600	>600	>LOD
		1 POINT	10 POINTS	10 POINTS	1 POINT	5 POINTS	UP TO 8 POINTS
Armrest/Center Console	1	1	10	10	1	5	8
Carpet	5	5	50	50	5	25	40
Dashboard	5	5	50	50	5	25	40
Hard Door Trim	1	1	10	10	1	5	8
Headliner	2	2	20	20	2	10	16
Seat Back	2	2	20	20	2	10	16
Seat Base	1	1	10	10	1	5	8
Seat Front	5	5	50	50	5	25	40
Shift Knob	1	1	10	10	1	5	8
Soft Door Trim	2	2	20	20	2	10	16
Steering Wheel	2	2	20	20	2	10	16