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The Case against Candle Resistant Electronics

(Updates at http://greensciencepolicy.org/standards.shtml)[1]

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Proposed candle flammability standards from the International Electrotechnical Commission (IEC), CENELEC, Underwriters Laboratory (UL), and Canadian Standards Association (CSA) would bring hundreds of thousands of tons[3] of potentially toxic fire retardant chemicals into homes, schools, hospitals, businesses—wherever electronic equipment is found. These candle flame resistance requirements threaten human health, the global environment, and the responsible recycling of electronics equipment. Current fire, health, and environmental data must be obtained and evaluated before the candle flame resistance requirements in Clause 21 Amendment 2 to IEC 60065; and Subclause 4.7.1 of Amendment 1 to IEC 60950; as well as similar CENELEC standards and amendments to UL60950-1 in the U. S. and the C22.2 no. 60950-1, 2nd edition in Canada are promulgated.

Executive Summary

The proposed IEC Standard 62368 "Audio/Video, Information and Communication Technology Equipment—Safety – Requirements" developed by TC108, was recently voted down by 58% of the IEC National Committees from 31 countries. The majority of the standard is similar to previous rigorous standards governing the safe functioning of electronic equipment which have proved effective at preventing fires, electric shock, etc. and generally do not have adverse health or environmental impacts.   However, the proposed standard introduced a new requirement (the "candle flame" or external ignition requirement) in Clause 7 that would have mandated that the plastic enclosures for nearly all audio, video and information technology products be highly resistant to external ignition from an open flame. The same requirement is found in the up-coming Amendment 2 to IEC 60065 as well as Amendment 1 to IEC 60950-1 and mirror CENELEC standards. (Appendix 3 lists expected effective dates and products impacted by six proposed product safety standards from the IEC and CENELEC containing provisions for candle flame resistance.) In addition, a similar amendment to UL/CSA Bi-national standard UL60950-1 and CSA C22.2 no. 60950-1, 2nd edition has been proposed by the National Association of State Fire Marshals and is due for balloting on May 19, 2008.

While on the surface these proposed provisions might seem beneficial, this paper will demonstrate that these requirements have not been shown to be needed for fire safety and their adoption will greatly diminish public and environmental health. Electronics products are currently well protected against the effects of internal heat and ignition; the candle flame resistance requirements will result in the unnecessary addition of flame retarding chemicals to the decorative/protective outer housings.

The data cited as justification for the proposed candle resistance standards do not meet the rigorous standard of proof normally expected for such a significant change. A review of the fire statistics from the U. S. National Fire Protection Association (NFPA) reveals that a very small number of open flame or candle fire injuries and deaths are associated with consumer electronics.[4] [5] The U.S. Consumer Product Safety Commission's (CPSC) National Electronic Injury Surveillance System (NEISS) report indicates that there are a limited number of instances where candles ignite electronics, and that according to the Consumer Electronics Association (CEA) "these incidents are so few and of such a nature that they do not appear to warrant a change in the product safety standards for electronic equipment."[6]

The central case used to justify the proposed requirement was an extraordinarily large number of TV fires in the 1990s in a suburb of Stockholm. Although this period was a statistical outlier, it was used to predict the expected fire rate in all of Europe, making the adoption of a proposed standard seem necessary to prevent a future increase to such a level. This study and supporting data are not representative of European fire data or the U. S. data with which they are compared and thus the conclusion is flawed.

Candle ignition of electronics is very rare and there have been no reported fatalities in the U. S. in recent years. Furthermore, a suite of new candle safety standards have been adopted by the candle industry in the U.S. and Europe to minimize fatalities and injuries associated with candle fires in bedding and furniture.

A fundamental principle of standards development, that changes should not be made primarily to give preference to select companies or industries, is violated by the proposed candle flame provisions. These requirements were motivated and are being promoted by the fire retardant manufacturers and their representatives – companies that stand to gain financially if these standards are adopted.

Proponents of the candle flame ignition section emphasize that the standard does not mandate the use of any particular chemical or technology to meet the requirements, and therefore would not in itself cause any negative health or environmental impacts as long as "safe" flame retarding materials could be identified. While technically correct, the least expensive and most familiar chemicals that could be used to meet the standard are brominated flame retardants (BFRs) and chlorinated flame retardants (CFRs).

Most BFRs and CFRs studied to date have been found to cause serious adverse health effects in experimental animals; notable are neurological impairments in brain development and reproductive abnormalities in organ development and sperm morphology. Most BFRs also show endocrine disrupting potential in vitro.[51] Many BFRs and CFRs have already been restricted due to their persistence, environmental mobility, and/or adverse effects on human health; others are being considered for restriction through RoHS and REACH in the EU. Many potential replacements for BFRs and CFRs, such as phosphates, lack adequate data to show they are safe for health and the environment.[7]

Many fire retardant chemicals can migrate out of consumer products; they are being found in rapidly increasing levels in dust, the food chain, pets, wild animals, and human fat, body fluids, and breast milk worldwide. The United States has much higher levels of fire retardant chemicals in dust, food, and breast milk than Europe[8] where fire retardants are less used. The average U.S. woman's body and breast milk contains fire retardants at levels approaching those that cause adverse reproductive and neurological health problems in animals. [56]

The possible adverse impact of these open flame standards on public health is enormous. A previous average annual production of 9,000 metric tons (20 million pounds) of the fire retardant chemical pentaBDE, used primarily in furniture in the United States, (currently prohibited in the EU and eight states in the U.S), has created a long term health and environmental hazard throughout the world. Hundreds of thousands of tons of flame retarding chemicals are likely to be used to comply with this standard. The chemicals currently used are either proven or suspected human and environmental toxicants or lack adequate health or toxicity information.[7]

Identifying effective fire retarding materials that also meet health and environmental requirements is difficult. One major BFR and CFR alternative is a class of fire retardants based on phosphorous; however, many of these chemicals have not been studied sufficiently to reasonably define their risks. Most phosphate fire retardants that have been studied are acutely and/or chronically ecotoxic. Phosphate flame retardants should be introduced into consumer electronics with caution. Only those chemicals with sufficient health and environmental data should be used. Manufactures should avoid substances that either lack data or pose unacceptable human and environmental health risks.

The addition of a variety of fire retarding chemicals into product housings will make responsible recycling of electronics more expensive and difficult. The rapid obsolescence of many consumer electronic products is leading to a huge expansion of the plastic waste stream. Increasing the fire retardant chemical load in this waste stream and introducing a mixture of retardants may make certain types of recycling cost prohibitive or even impossible. These standards would be likely to cause more downcycling and energy recovery (burning) to occur. In addition, brominated and chlorinated fire retardants form highly toxic dioxins and furans during the controlled and uncontrolled combustion that is still the unfortunate end-of-life fate for much of the world's electronics.

Many consumer products such as books, clothing, and bedding are made with materials such as paper, fabric, or plastic that will burn if exposed to a candle flame. Treating everything in our homes and businesses with chemicals to prevent candle ignition is neither a cost effective nor a sensible course of action.

Fire retardant chemicals are most appropriate in cases where there is a documented fire hazard that can be met with a relatively low hazard level from the chemicals. Reactive FRs that are bonded to the substrate are much safer than additive ones that are not bonded and can migrate out into the environment. For example, tetrabromobisphenol A, (TBBPA) bonded to the substrate inside electronics, will protect against failed electric systems catching fire. This use of reactive TBBPA inside electronics presents a lower health and environmental hazard than TBBPA used as an additive fire retardant in the plastic housing of electronics. For all uses, the hazard of manufacture to workers and those living in the vicinity of the plant as well as disposal should be considered.

Fire retardant chemicals can delay or sometimes stop fires; however they have a high potential health and environment cost. Sprinkler systems can stop fires without polluting or threatening human health. Other effective ways to reduce fire deaths and injuries include increased use of smoke detectors, child-safe lighters, fire safety education, fire-safe cigarettes and candles and design changes in products that avoid need for chemical fire retardants.

Usually major changes in product regulation are driven by a need to address issues and the solutions are proportional to the problem being addressed. Since there is not evidence of a significant need for protection of electronic products from candle ignition, and since the costs and adverse outcomes from this change would be so out of proportion to the problem even using the most conservative data, this major modifications to the global electronic safety standards defined these open flame standards is not justified.

58% of the voting member countries in IEC TC108 USTAG have voted "No" to the candle flame requirements contained in clause 7 of the draft IEC 62368 standard till environmental studies are conducted to determine its impact.

The same document containing Clause 7 is currently under parallel vote in CENELEC, the electrotechnical standards body in the EU, as prEN 62368 with the same deadline of 25 April, 2008. Furthermore, IEC TC 108 committee has added the same requirements to the upcoming amendments to IEC 60065 and IEC 60950-1 with mirror CENELEC Standards EN 60065, pr A11 and EN 60950-1. In addition a similar amendment has been proposed to Underwriters Laboratory standard UL60950-1, 2nd edition and to the Canadian Standards Association C22.2 no. 60950-1, 2nd edition.

For the reasons outlined in this paper, we also ask the IEC national committees to also vote "No" to the candle flame retardancy amendments in IEC 60065 and IEC 60950-1; for CENELEC to vote "No" on prEN 62368, EN 60065, pr A11, and EN 60950-1; for Underwriters Laboratory to vote "No" on the open flame standard

amendment in UL60950-1, 2nd edition; and for the Canadian Standards Association(CSA) to vote No on C22.2 no. 60950-1, 2nd edition.

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Section I: What is the Proposed IEC Standard 62368?

The proposed IEC Standard 62368 “Audio/Video, Information and Communication Technology Equipment—Safety – Requirements” improves upon past standards governing the safe functioning of electronic equipment. It also introduces a new “candle requirement” in Clause 7 that would require that the plastic enclosures for most audio, video and information technology products likely to be used in homes be highly resistant to external ignition from a small open flame.

What Are The Existing Fire Safety Standards For Electronic Devices?

Electronic products today are designed according to strict safety standards, IEC 60065 and IEC 60950, which minimize the risk of fire from internal heat and ignition. Examples of the products covered are listed in Table 1. Manufacturers can use flame retardants inside their products and /or design strategies to meet these standards. For example, the power supplies for most printers are contained in enclosures external to the unit to separate high voltage areas from plastics.

Table 1. Flammability Standards for Electronics and Affected Products

Standard	Example Products Affected
IEC 60065: Audio, video and similar electronic apparatus safety standard	All Televisions (TVs) including plasma TVs
EC 60950-1 Information technology and telecommunication equipment safety standard	Monitor, personal computer Printer, scanner, fax machine, copier, calculator Photo-printing equipment for home use Monetary processing machines for home use Telephone sets, pager, modem
Future IEC 62368: Audio/video, Information and Communication Technology Equipment – Safety Requirements	All Televisions (TVs) including plasma TVs Monitors, personnel computers Printer, scanner, fax machine, copier, calculator Photo-printing equipment for home use Monetary processing machines for home use Telephone sets, pager, modem Audio, CD/DVD players, satellite receivers Game machines Video cameras Electronic musical instruments.

How Is the Candle Flame Resistance Requirement Different from Current Requirements?

The proposed standard, IEC 62368, would incorporate the existing standards as above and add a new requirement in Clause 7 that external housing of electronics would have to withstand a three-minute contact with a candle flame without catching fire. Design strategies alone would usually not be sufficient to achieve compliance with the proposed standard, which means the addition of chemical flame retardants to the housing would be most likely.

What Level of Flame Protection Must Be Met Under the Proposed Standard?

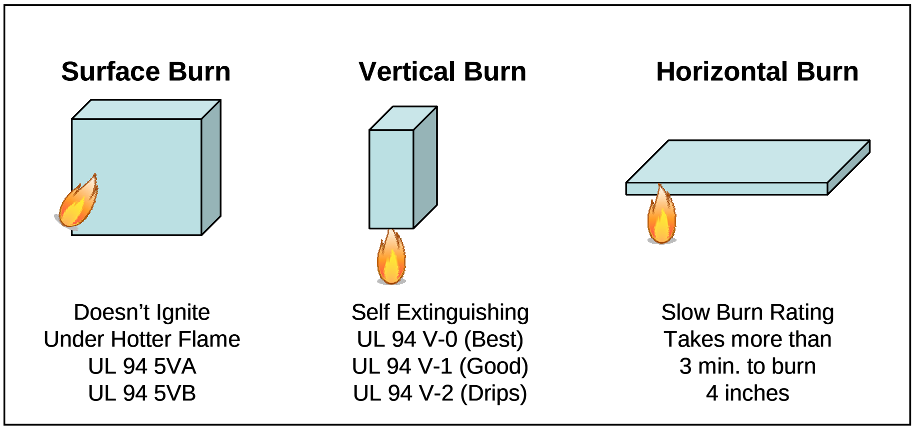
Table 2 below shows the Underwriters Laboratory ratings for flammability of electronic housings. Materials inside electronic appliances currently need to meet minimum flame rating levels (usually V-0), which means they will readily self-extinguish after contact with a vertical flame. They are designed to compensate for electrical faults which may cause thermal spikes, sparks, or flames.

Most outer housing materials currently used are rated HB without any added chemical flame retardants, although some product housings are also required to have higher flame ratings if they act as part of the protective enclosure in the case of an internal fault. HB stands for "horizontal burn" and the standard requires that if a flame is applied to the material it will take more than three minutes to burn four inches in a horizontal direction (see Figure 1 below). The outer housings for most consumer electronics are currently not required to meet higher flame ratings if there is a fire enclosure for protection against internal ignition. The outer housings are required to meet V-ratings if they are used as fire enclosures. The proposed candle resistance standard would require the plastic in the outer housing to be rated V1 or higher which means it will readily self-extinguish when an external vertical flame is applied. See Figure I for a more detailed explanation of the levels of flame retardancy.

Table 2. Flame-retardancy ratings

UL94 Ratings for Electronics Housings	Flammability
5VA	*More Flame Resistant*
5VB	
V-0	↓
V-1	
V-2	
HB	*Less Flame Resistant*

Figure 1: Definition of UL94 Ratings for Electronic Housings



What Types of Flame Retardants Are Likely To Be Used To Meet This Standard?

Acrylonitrile butadiene styrene (ABS), high impact polystyrene (HIPS), and blends such as HIPS/ Polyphenylene (PPE), which are used in nearly all consumer electronic housings, are naturally flame resistant to the level HB. The proposed candle flame resistance requirement in IEC 62368 requires that external housings have a flammability rating of at least V-1.

To meet the proposed standard in Clause 7 of IEC 62368, manufacturers are most likely to add flame retarding chemicals to the currently used electronic housing materials, HIPS and ABS. A variety of fire retardants can and will be used to comply with the IEC standard. The fire retardants that are most cost effective and most commonly used in plastic at the present time are brominated flame retardants (BFRs) and chlorinated flame retardants (CFRs).

HIPS, the lowest cost and most widely used plastic in electronic enclosures, is currently most often flame retarded with decabromodiphenyl ether (decaBDE). ABS is most frequently flame retarded with tetrabromobisphenol A (TBBPA). These flame retardants, when used in electronics housings, are added to rather than chemically bonded with exterior plastic. Therefore they can migrate out of the plastic into the surrounding environment.

A great deal of new information is currently emerging with regard to the negative health and environmental impacts of using BFRs and CFRs in consumer products. This will be discussed in Section III of this report. Several chemicals in this class have already been restricted due to their persistence or adverse effects on health, including such conditions as neurological impairments, reproductive abnormalities, endocrine disruption, and cancer.

An additional potential hazard is that Antimony Trioxide, Sb_2O_3, is usually used as a synergist along with BFRs in electronics housings. This chemical is listed by the state of California to cause cancer under Proposition 65 and, along with all antimony compounds and brominated flame retardants, is considered a declarable substance in the electronics industry's Joint

Industry Guide, JIG-101A.

Some of the larger computer companies such as HP, Dell, and Apple have committed not to use BFRs. However, as can be seen from Table 3 below, BFRs are currently less expensive than phosphates and some other alternatives, and as such, are expected to be used at least to some extent if the proposed Clause 7 candle requirement is enacted.

Currently 45% of the fire retardant usage in the U.S. is BFRs; Europe uses 11% BFRs and 17% CFRs. It is reasonable to assume that increased usage, at least for the near future, would follow a similar pattern.

Table 3. Estimated TV Flame Retardants Cost to Meet the V-0 Standard

Fire Retardant Chemical	Average Cost	Percent of $300 TV
DecaBDE (BFR)	$11.21	3.7%
Other BFRs	$14.55	4.9%
Bisphenol A diphosphate	$18.18	6.1%
Phosphate esters	$22.00	7.3%
RDP	$23.03	7.7%

(Source: Lowell Center for Sustainable Production)

Section II: Development of the IEC Candle Flame Resistance Portion of Standard 62368

In the year 2000, the U.S. National Association of State Fire Marshals (NASFM) began a campaign to require major electronics manufacturers to make their product housings candle flame resistant to an extent that would require fire retardant chemicals. The NASFM claimed that the external ignition of consumer electronics was a major fire hazard.

In response to the Fire Marshals campaign, the Information Technology Industry Council (ITI) and the National Fire Protection Association (NFPA) conducted a Safety Forum, held in March 2000. Participants included representatives of Underwriters' Laboratories, the CPSC, and the Building and Fire Research Laboratory of the National Institute of Standards and Technology (NIST). The fire marshals representatives were invited, but did not attend.

John Hall, director of the fire statistics and research division of NFPA, presented data and concluded that "external ignition of IT equipment does not pose a level of risk that should be considered a safety policy priority." Bill King, Chief Engineer for Electrical and Fire Safety at CPSC, said he had personally gone through 75 [fire] data items collected by CPSC over a five-year period and found no evidence of the type of incidents cited by the fire marshals. [9]

Nonetheless in 2002, Robert Polk of the U.S. NASFM submitted a proposal to the IEC recommending a candle flame standard for electronics equipment. This proposal was the origin of the IEC TS 62441 which is now Clause 7 in the proposed IEC 62368. The impetus and momentum motivating the candle standard has continued to come from NASFM. Four documents, cited by NASFM as justifying the standard in its proposal,[10] are discussed in Appendix I.

A CPSC Monitor article of January 1, 2001 wrote of lobbying reports on file in Congress as of August 1999 indicating that the fire marshals' Washington representative, Sparber and Associates, received compensation from the Bromine Science and Environmental Forum, funded by the Albemarle Corp, Great Lakes Chemical Co., and two non-U.S. chemical manufacturers. [11] As discussed in more detail in Clause IV, Peter Sparber was the founder of the NASFM [75] and continues to be their liaison to the government and the CPSC [78]. The fact that Sparber is a paid lobbyist for the fire retardant chemical industry suggests the NASFM is not an impartial party. Sparber and the NASFM are connected to an industry that will gain a substantial financial benefit from the adoption of open flame standards for electronic housings.

The literature, when reviewed, does not demonstrate a need for a candle flame resistance requirement for consumer electronics. Since 2000, NASFM has continued to push for an open-flame standard for electronic enclosures without demonstrating a fire safety rationale.

Do Candle Fires in Consumer Electronics Present a Clear and Present Danger?

John Hall of the National Fire Protection Association (NFPA), America's leading fire statistician, published a paper in 2002 showing there were an insignificant number of candle fires in consumer electronics in the United States. His paper entitled, "Fires involving appliance housings – is there a clear and present danger?" concluded there was not a hazard.[4]

Hall estimated that an average of one death annually between 1993-1997 in the U.S. was attributable to candle ignition of all appliance housings, including those of washers, dryers and stoves. Consumer electronics were only a part of this total. This implies an annual death rate of less than one from fires initiated by open flames -- a statistically insignificant number. **Hall wrote that fires ignited by open flames in appliance housings were primarily very small fires that did not spread beyond the appliance.**

This situation has not subsequently changed in the U.S. as documented in a 2007 NFPA report on the number of candle fires.[5] The NFPA report estimates 400 candle fires annually associated with all appliances, averaging less than one death per year in the U.S., and equivalent to 7% of all appliance fires. One estimate, based on appliance waste measurements, is that approximately 20% of appliance waste is consumer electronics.[12] Thus, one could estimate that approximately 80 candle-ignited electronics fires occur per year, resulting in well below one death per year in the United States. External ignition of appliance housings ranking 13th on the list of items first ignited by candle and accounting for only 1% ($5M) of direct property damage per year**.**

Both NFPA reports lead to the same conclusion: Candles (or any other external small open flame) account for a small share of the appliance housing fires and appliance housings as first items ignited account for a small share of the candle fires.

IEC Special Fire Research Group Report

After receiving the NASFM proposal for an open flame standard for electronics housings, the IEC created a Special Fire Research Group (SFRG) to assess:

1) the probability of fires caused by open flames external to consumer electronics housing;
2) conditions that might cause these fires;
3) the environmental implications of suggested precautions/safeguards (e.g., addition of flame retardant chemicals to electronics housing) over the intended lifecycle of the product.

The 2003 SFRG final report[13], quoted in Appendix 2, did not conclude that fire protection from small open flame fires was a priority. The SFRG report did not discuss the potential health, environmental, and recycling impact of flame retardant chemicals that would be used to meeting this standard.

Furthermore, the SFRG did not contain a significant number of impartial academics or representatives of NGOs with health or environmental expertise, who should be included in any future evaluation.

Since the time of the report, there has been a vast amount of new fire, health, and environmental data. TC108 needs to demonstrate a valid fire safety rationale for Clause 7 before moving forward with the candle resistance requirement. This is critical in light of the potential for severe negative human health, environmental, and recycling impacts from the increased usage of chemical fire retardants such as those currently used to fire retard plastic enclosures of consumer IT and audio / video equipment.

NASFM Justification on the Need for a Candle Standard is based on a Projected Future Hazard

NASFM's call for a candle standard rests not on a current documented problem of fires in consumer electronics, but on a potential future problem. This claim is based on a comparison of television fires in the U.S. with those in one suburb of Stockholm that had an extraordinarily high fire rate in the 1990s.

Margaret Simonson et al[14] is the primary reference for the high frequency of fire in Europe. Her estimate comes from a paper by de Poortere *et al.*[15] that purports to show that Europe, which uses UL-rated HB plastics with no additive flame retardants, has a much higher TV fire frequency than does the U.S., which uses plastics with flame retardants, or UL-rated V0 plastics. The research was funded by the European Brominated Flame Retardants Industry.

The use of TV fire data from one suburb of Stockholm Sweden as a basis for a regulation covering all consumer electronics is questionable. TVs are only one product in the greater category of "consumer electronics." In this study, internally caused fires are not separated out from those caused by external open flames in the home. The vast majority of TV and consumer electronics fires result from internal electrical malfunction; these should not have been included.

Ignoring this issue, de Poortere proceeded to argue that the HB plastics used in Europe caused more open flame fires in electronics housing than the VO plastics used in the U.S. However, instead of compiling statistics on fires from various European countries, de Poortere extrapolated the rate of TV fires per million TV sets in one suburb in Stockholm, reported in a study called the Vallingby project. De Poortere states, "The Vallingby project results, because of the thoroughness of the methodology are more representative of a wider European reality." The Vallingby study is not referenced, nor is its methodology explained or compared with the methodology used in the United States.

The Stockholm suburb in the Vallingby study had a much higher rate of fires per million TVs than the numbers given for the Netherlands, previous reports for Sweden, and the numbers in the 2001 UK Department of Trade and Industry report "Causes of fire involving television sets in dwellings".[16] (See Figure 2 below comparing the data used by the NASFM, Simonson, and de Poortere documenting the frequency of European TV fires with data from England, the Netherlands, and Norway.) Based on this artificially high estimate of "European" TV fires, de Poortere *et al.* 2002 concluded that Europe has many more TV fires than the U.S., due to the use of HB plastics.

The 1991 to 1995 fire occurrence they cite appears to be an anomalous spike. The relevant number is the number of externally caused fires for all consumer electronics. Such numbers for the U.S., but not Europe, can be found in John Hall's 2002 paper, as cited above. The NASFM proposal cites the Hall paper but does not acknowledge his conclusion that there was not a significant fire problem involving small open flame ignitions of appliance housings from the 1980s through the mid 1990s in the U.S.

Figure 2. TV Fires/ million TVs

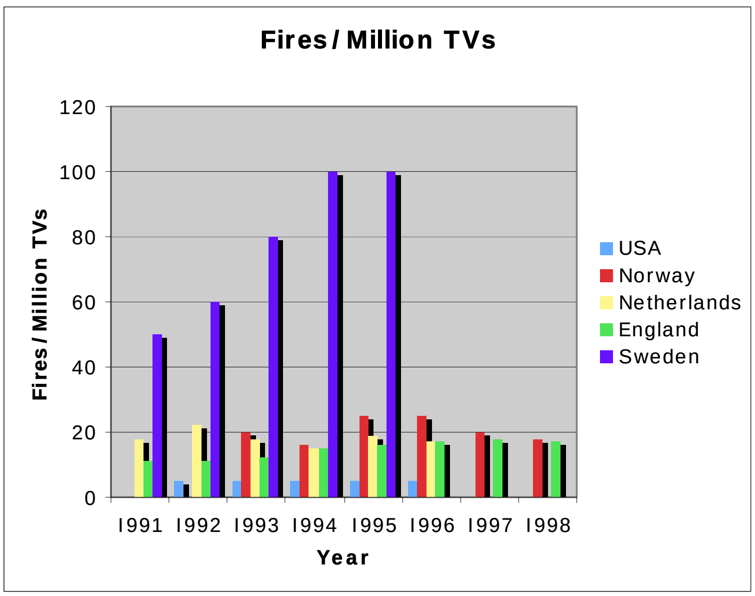


Figure 2 demonstrates that TV fires in the single report from Sweden cited by the NASFM and Simonson are not representative of the rest of Europe. (Data for the USA, England, and Norway are from the DTI study and Sweden and the Netherlands are from Poortere)

What Is The Risk Of Candle Ignition For Consumer Electronics?

The Consumer Electronics Association (CEA) reported that only five injuries involving the ignition by candles of appliances, only one of them serious had been reported to the US Consumer Product Safety Commission over 11 years on a hotline set up for consumer product-related fire and burn injuries. Based on this data, the CEA concluded that "these incidents are so few and of such a nature that they do not appear to warrant a change in the product safety standards for electronic equipment."[6]

According to a Telecommunications Industry Association report in 2005: “It is the conclusion of subcommittee TR41.7 that the proposal as it currently stands is without merit and should be rejected. …it does not seem prudent to add arbitrary requirements that may increase the use flame retardants without a demonstrated need.[17] The TIA wrote again in 2007, “The new rationale does not offer any additional information or substantiation that there is a problem to be solved specific to this kind of equipment…. In addition, no data has ever been presented that the proposed requirements would address the stated (but so far unsubstantiated) concerns.[18]”

It should be noted that four sources—CPSC (2000), Hall (2000 and 2002), Consumer Electronics Association (CEA), the Telecommunications Industry Association (TIA)—have concluded that the risk of candles igniting consumer electronics is low, the latter two stating it is, in fact, too low to justify this requirement.

It is not clear why the IEC standard-setting group seemingly chose to disregard these four sources in favor of the bromine industry-sponsored study concluding that candle ignition of consumer electronics poses a serious fire safety threat. The Vallingby study upon which the proposal is based is not peer reviewed, does not provide sources, and is out of line with other published and peer reviewed data.

Alternatives to Fire Retard Chemicals Prevent or Stop Fires without Impacting Health or Environment

Fire retardant chemicals can stop the ignition of plastic electronics housings from a small, open flame such as a candle, but treated housings will still ignite in a larger fire scenario, such as a wastebasket-sized fire. The potential future small benefit of retarding candle-sized fires in the plastic enclosures of consumer electronics comes at a very large potential cost to health and the environment.

Fire safety technologies such as sprinkler systems can also stop larger fires without polluting or threatening human health. Other effective strategies to reduce fire deaths and injuries include increased use of smoke detectors, child-safe lighters, and fire safety education as well as fire-safe candles and cigarettes.

The leading cause of fire deaths is cigarettes. The most effective fire safety strategies are campaigns to reduce smoking and the introduction of reduced ignition propensity (RIP) or” fire-safe”, cigarettes. In the last 25 years, annual cigarette-caused fire-related deaths in the U. S. have declined dramatically from 2,000 to 700. U.S. legislation requiring fire-safe cigarettes and the recent adoption of similar regulations in Europe should reduce such deaths even further. Meanwhile, smoking rates for Germany, France and the United Kingdom had declined to slightly over 26% by 2003, and in the United States to just 21% by 2004. The diminishing fire death rate should reduce the rationale for increasing the level of potentially hazardous fire retardant chemicals in consumer products.

New Standards for Fire-Safe Candles Should Reduce Candle Fires

In addition to the already low incidence of candle ignition of electronics, new candle safety standards have been adopted by the candle industries in the U.S. and Europe to minimize fatalities and injuries associated with candle fires in bedding and furniture. [19]

During the period from 1990 to 1998, U.S. candle consumption increased 350%. Although candle-related fire injuries and deaths increased at much slower rates of 13% and 42% respectively, improving candle fire safety became the objective of the candle industry and the Consumer Product Safety Commission (CPSC). Working through the American Society for Testing and Materials (ASTM), standards were developed to address candle fire safety issues, using the following approach:

- Research and understand the root causes of candle fires
- Create manufacturing standards to reduce and/or eliminate root causes
- Work with retailers to require these standards in their candle specifications.

As a result, ASTM has instituted candle manufacturing standards that address public education of candle hazards through labeling, glass container material requirements to eliminate shattering due to candle heat, and improved candle design to minimize the four most prevalent causes of candle fires: excessive flame height, secondary ignition, end of useful life, and stability. Complying with these standards requires a manufacturer to design and produce candles with warning labels, with a maximum wick length, without combustible decorative materials, that will self extinguish without incident when they have burned down, and be proportioned to not tip over up to an angle of 10 degrees.

Ninety percent of US candle manufactures have pledged to comply with these standards. The ASTM is actively working with major retailers, distributors, and importers to ensure that these safety specifications are also met by imported candles and accessories. As a result, the ASTM estimates that the majority of all candle and candle accessory products sold in the U.S. are in compliance with the fire safety standards.

There are similar candle standards initiatives in Europe. A European committee for standardization (CEN) task force for candles in Europe is in place to similarly define standards and work with European candle producers to improve the safety of candle use.

The widespread implementation of these standards designed to address the root causes of candle fires has improved candle fire safety and should reduce candle fire injuries and deaths in ignitions of furniture and bed clothing.

Section III: Adverse Impacts of Implementing the Candle Flame Resistance Standards for Electronic Housings

Effect of the Candle Resistance Requirement on Electronics Recycling

The proposed candle flame resistance requirements to protect housings from external ignition by small, open flame would essentially mandate that external product housings have a flammability rating of at least V-1.

Materials with a flame rating of HB are commonly used for the external housings of many consumer products. The existing requirement to contain fires from internal sources allows for the widespread use of HB-rated plastic materials (ABS, HIPS, and PP blends) for most external housings, without adding flame retardants. These materials account for 87% of recycled electronics plastics and can be reused repeatedly without degradation.[20]

With the increasing cost of oil, the cost of recycling ABS and HIPS is now competitive with the cost of using new materials. After many years of effort, electronics recycling is slowly becoming cost effective. The proposed candle requirement in Clause 7 and the other open flame standards are very likely to slow or reverse this progress as described below:

(1) Less recycled material would be available for use in new products

By far the preferred method for disposing of plastics at end-of-life is mechanical recycling because it closes the loop and reduces the need for additional virgin material to be extracted and produced. Mechanical recycling requires plastics to be shredded and sorted by resin type in order to provide homogenous plastic waste, which can then be put through a melt reprocessing step, and combined with new material to produce a blend that is (ideally) comparable to virgin material. If the properties of recycled material are not comparable to virgin material, it must then be “downcycled” into less demanding applications. It is currently possible to recover high-purity ABS through a variety of recycling approaches, and there is an active market for the recycled material.

Several BFRs are known to degrade the mechanical properties of recycled engineering plastics,[21] although many of these problems are solved by using more chemical additives. More importantly, after bromine-containing plastics have passed through the basic recycling process, the additional thermal stresses from the new product manufacturing processes, such as extrusion, compounding and molding, can lead to an increase in PBDD/F concentrations (dioxins and furans) above legal limits. Therefore, mechanical recycling of bromine-containing electronics waste is often not recommended.[22]

BFRs, as previously discussed, will be used to meet the flammability requirements by some manufacturers for reasons of cost and familiarity. Some major electronics producers have made public commitments to eliminate BFRs from product housings, which would mean that other flame retardant chemistries would be introduced to meet the proposed requirement. There has been little research on the effects of non-BFR flame retardants on the mechanical properties of recycled resins. Based on the negative impact that these chemicals have on the properties of virgin materials (poor mechanical properties, thermal stability, and molten rheology, etc.), residual non-BFR flame retardants will almost certainly degrade the properties of recycled ABS and HIPS.

Using commercially available ABS and HIPS (with no added flame retardants) in the housings of electronics whenever possible greatly improves the probability that recycled plastic can be introduced into equivalent products because the mechanical properties are maintained after recycling. The introduction of flame retardant chemicals to all ABS and HIPS housing in order to meet the candle flame resistance requirement will result in degraded mechanical properties of material recovered from electronics housings when it is recycled, making it harder to incorporate recycled content into equivalent products, and forcing more “downcycling.”

(2) Recycling of plastics containing a mixture of flame retardants would cost more which could lead to more burning of plastic.

The EU directive on Waste from Electrical and Electronic Equipment (WEEE) which was promulgated in 2003 aims to increase the re-use, recycling and recovery of waste from a wide range of consumer products. Annex II of the WEEE Directive requires the “selective treatment of plastics containing BFRs,” so plastics containing BFRs are separated prior to recycling or energy recovery. However, it is unlikely that most recyclers would be able to cost effectively separate plastics containing a variety of fire retardant chemicals. It would be labor intensive and the analytical tools available for identifying chemicals in materials are limited to elemental detection of a number of substances. For example, hand-held x-ray fluorescence (XRF) equipment would be able to detect elemental phosphorous in non-BFR plastics, but would not be able to differentiate between the various phosphorous compounds. Different phosphorous compounds exhibit different chemical behaviors and would produce a variety of combustion byproducts. Gravity separation, often used to refine the waste stream, would not differentiate between different fire retardants.

Since all non-BFR plastics would be shredded together, the resulting regrind from mixed flame retarded plastics could have unpredictable and undesirable qualities,[22] even within the same base resin. If mixed, untreated regrind is “downcycled,” the reduced market value of the lower grade of material could threaten the economic viability of the recycling industry, as would any additional post-processing treatments needed to homogenize, purify, or otherwise improve the material.[22]

Although mechanical recycling is increasing, only about 16% of plastics are mechanically recycled today in Europe,[23] with lower rates in other regions. Electronic materials already pose a challenge for mechanical recycling because separating the plastics is difficult due to the complexity of the products. Introducing a wide range of flame retarding chemicals into product housings to meet the proposed standard would make mechanical recycling even less profitable, or perhaps impossible in some cases, so that much of the waste material currently being mechanical recycled will be diverted to energy recovery (burning), with negative impacts for the environment and public health.

(3) Emissions from energy recovery exhaust could have unknown and potentially toxic composition.

Energy recovery is vastly inferior to mechanical recycling in that it destroys material that could be incorporated into new products. However, it is one way of treating mixed and soiled plastics in the waste stream, and about 30% of post-consumer plastic waste is treated through energy recovery in municipal incinerators in Europe.[23]

Energy recovery involves the combustion of plastic materials in order to recover energy for producing electricity, steam, or heat. Research is ongoing to increase thermal destruction of brominated dioxins and furans in solid waste treatment facilities.[24] [25] Little is known about the effects of alternate flame retardant chemicals on combustion in incinerators and smelters; they will make the attempt to improve incineration even more complex. In particular, many phosphorous compounds are known to exhibit acute ecotoxicity, and the composition of the combustion byproducts of plastics containing these flame retardants is unknown.

(4) Outdoor burning of electronics and unplanned fires could result in uncontrolled emissions containing dioxins, furans, and other toxic compounds

Much of the concern about BFRs and CFRs in electronics is due to combustion byproducts, including dioxins, furans, their brominated analogs, and other toxic compounds, produced in uncontrolled, open pit burning of waste that occurs in the informal recycling network and in unplanned fires in locations such as landfills. There are numerous reports documenting the risks to workers, surrounding communities, and ecosystems near electronics waste dismantling and burning sites.[26] [27]

Although the goal is to eliminate these dangerous practices, the reality is that uncontrolled incineration is still the end-of-life fate of a significant portion of electronics products. Many product housings will end up in the informal recycling system or be burned in an unplanned fire in an uncontrolled way. In addition, with the reduced financial viability of legitimate recycling, additional consumer electronic waste that cannot be otherwise economically recycled may be added to the more than one million tons of electronic product waste shipped to China from the U.S. and EU each year.[28]

Even within the legitimate solid waste treatment system, exhaust with toxic combustion byproducts of flame retarding chemicals continue to be released in many areas. The burden of the additional hundreds of thousands of tons of flame retarding chemicals and the resulting dioxins, furans, and other toxic pollutants from V-1 housings to meet the candle flame requirements will fall disproportionately on communities already affected by uncontrolled incineration of electronic waste.

Complying with the proposed candle flame resistance requirement could set in motion an environmental crisis with a time delay because it takes time for most electronic products to reach the waste stream. It could be many years before the full impact of the additional flame retardant

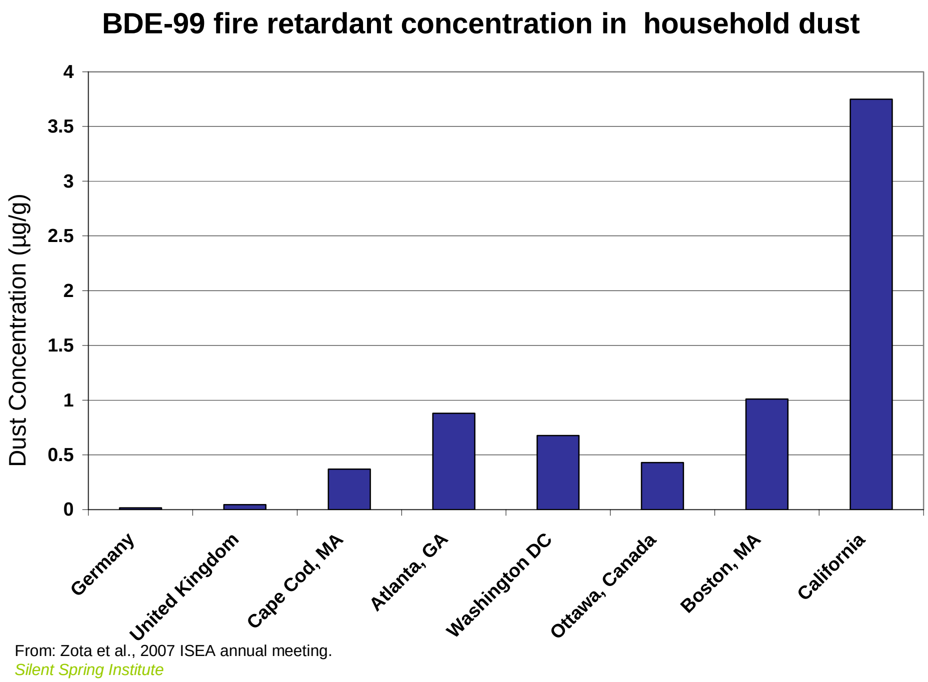
Human and Environmental Health Impacts of the Candle Resistance Requirement

If the IEC candle flame resistance requirement was adopted today, hundreds of thousands of tons (hundreds of millions of pounds)[3] of fire retardant chemicals would be added to consumer electronics annually. The least expensive chemicals that could currently be used to meet the standard are BFRs and CFRs. These chemicals, which have been in use in furniture, draperies, carpets and some electronics for as long as three decades, are known to migrate out of these products into dust and the environment at large; they are being found in increasing levels in human fat, body fluids, and breast milk worldwide. They have entered the food chain and are most noticeably found in fish and meat. They are also being found in animals with low proximity to humans such as Tasmanian devils and polar bears.[29]

The U.S. has the highest levels of PBDE fire retardants in consumer products and has much higher levels of these BFRs in dust, food, and breast milk than the rest of the world. California, the only state in the U.S. with an open flame standard for furniture, has 3 to 8 times the levels of toxic BFRs in house dust compared to other parts of the nation. U.S. levels are ten times higher than European levels[8] as can be seen in Figure 3 below.*

*It should be noted that health information can only be obtained after chemicals have been used for a significant period of time. The most quantified information currently available is for pentaBDE, which is closely related in structure to decaBDE commonly used in TVs and other electronics. Although banned in the EU and much of the US, pentaBDE continues to migrate from products in consumers' homes contributing to sustained exposures.

Figure 3: Comparison of the fire retardant chemical BDE-99, a toxic pentaBDE congener, in dust samples from Europe and six locations in the US.[8]



California, which has the highest level of fire retardants from use in furniture foam, has the highest level in dust and in breast milk as well.[30]

The US in general is known to have a much higher level of toxic pentaBDE congeners such as BDE-99 in dust, breast milk and body fluids than does Europe. In the US, median human pentaBDE levels in breast milk range from 34 to 58 nanograms PBDE per gram lipid weight which can be compared to levels of 1.3 in Japan, 2.0 in Poland, and 3.2 in Sweden in similar studies as shown in 4.[31]

Table 4
Recent studies of PBDE levels in human breast milk

Study (US)	Year collected	Population	Number of subjects	Median ng/g lipid weight	Range ng/g lipid weight
Schecter et al	(2003)	Texas	47	34	(6.2- 419)
Lunder, Sharp	(2003)	US	20	58	(9.5 to 1,078)
She et al	(2004)	NW US	40	50	(6 to 321)
Wu et al	(2004)	Boston	40	30	(4.3 to 264)
(Outside US)					
Eslami et al	(2004)	Japan	105	1.3	(0.01-23.0)
Jaraczewska et al	(2004)	Poland	22	2.0	(0.8-8.4)
Lind et al	(1996-99)	Sweden	93	3.2	(0.9-28.2)

Chemically similar retardants are likely to be used if this proposal is passed, and could similarly end up in dust, human and animal bodies and breast milk.

In animal experiments, PBDEs and other BFRs and CFRs have been reported to cause thyroid disruption, reproductive, neurological and developmental problems, and cancer.[32 33 34 35] In addition the breakdown products and/or metabolites of these chemicals exhibit some of the same toxic effects.[7]

At present decaBDE and TBBPA are the BFRs primarily used in plastic electronics housings and their usage could considerably increase, possibly by as much as two or three-fold. While both decaBDE and TBBPA are less bioaccumulative than the lower PBDEs, they have been detected in invertebrates, fish and sediments;[36 37] predatory bird eggs;[38 39] and human serum[40] and have the potential to cause adverse health and environmental effects. Also, DecaBDE does breakdown to lower, more persistent PBDEs.[46] DecaBDE and TBBPA, like most other fire retardant chemicals, continue to be used in consumer products without adequate knowledge of potential health and environmental effects.

In 2003, the European Union (in the RoHS directive 2002/95/EC) and California enacted legislation banning pentabromodiphenyl ether (pentaBDE) and octabromodiphenyl ether (octaBDE). Eight other states followed suit. In 2004, the remaining U.S. manufacturer voluntarily ceased production.

The phase-out of pentaBDE and octaBDE was due to a number of studies demonstrating bioaccumulation and adverse health effects in experimental animals, notably disruption of thyroid hormone balance and neurological and developmental effects. Exposures early in life caused irreversible changes in spontaneous behavior and learning and memory deficits that were permanent and increased in later life.[41] Other studies have found that polybrominated diphenyl ethers (PBDEs) actually change certain brain receptors.[42] The fire-retardant decaBDE, which continues in common use in draperies, consumer electronics, and small appliances, has been found to cause the same changes in spontaneous behavior, learning, and memory as the less brominated BDEs.[46]

PBDEs are similar in structure to thyroid hormone, and exposures causes decreased thyroid hormone levels (serum T4) in mice, rats, kestrals, and frogs.[43 44] Disruption of thyroid hormone balance may well contribute to the neurobehavioral effects and changes in brain functioning observed after PBDE exposures. The National Toxicology Program (NTP) has found that there is some evidence of carcinogenicity of decaBDE in experimental animals.[45]

DecaBDE was recently banned in Sweden in all applications except electronics, Washington State, and Maine based on extensive research showing that it is accumulating and debrominating to form the more toxic less brominated BDEs.[46] At least 10 other U.S. states are considering legislation to ban decaBDE.

The European Court of Justice handed down its judgment ending the decaBDE exemption from RoHS on 1 April 2008. The European commission accepted this ruling and set 30 June 2008 as the final cut-off date for placing new electric and electronic goods containing the decaBDE on the market.[47]

TBBPA is the most highly used brominated flame retardant worldwide and has been marketed as a safe, non-toxic flame retardant. However, its long-term toxicity has not been adequately evaluated. The NTP is currently conducting a two-year cancer bioassay in mice and rats.[48] *In vitro* studies have established that TBBPA is cytotoxic, immunotoxic, and disrupts thyroid hormone homeostasis.[49] TBBPA is also a potent inhibitor of estradiol sulfotransferase *in vitro*[50 51]suggesting that TBBPA exposure may lead to elevated estrogen levels if inhibition of this enzyme occurs *in vivo*. A recent *in vivo* study has found high estrogenic activity in ovariectomized mice after TBBPA exposure.[52] A decrease in circulating thyroxin has also been shown *in vivo* after TBBPA exposure in a reproduction study in rats.[53] That study also found increased testes and pituitary (male) weights and correlations with other developmental parameters.

Other brominated flame retardants might also be used to meet a new IEC standard. These might include bis(tribromophenoxy) ethane or decabromodiphenylethane, flame retardants for which little or no toxicity data are available.

Phosphates are the other major class of fire retardants that could be used to meet the IEC candle standard. Currently they are more expensive and not yet available in large enough quantities to replace BFRs and CFRs, should the latter be phased out. The phosphates that have been studied are highly ecotoxic; for most, comprehensive data about long-term health and environmental effects is not available.

An important question is whether fire-retardant chemicals cause the same adverse health effects in humans as they do in multiple species of animals. The most data is available for PBDEs which are found in high levels in house dust and dryer lint [54] as well as in the food supply, especially in meat and fish.[55]

A recent review relating PBDE body levels in humans to those measured in animals that were fed PBDEs allows for quantitative comparison between animal and human exposures. [56] The most probable health impacts from PBDE exposure are reproductive and neurodevelopmental changes. For US women, the highest five percent of those measured were found to have PBDE tissue concentrations equal to those that cause reproductive changes in experimental animals and within a factor of ten of the level that causes neurological changes.[57 56] This is especially problematic during pregnancy when exposure to very low levels of endocrine disrupting chemicals can increase neurological, reproductive, and developmental problems in the unborn child as well as cancer.[58] Many brominated chemicals are known or suspected endocrine disruptors. [51 59] This suggests a small margin of safety for developmental toxicity of BFRs for children born to U.S. women.

According to the 2008 Faroes consensus statement, “New research on rodent models shows that developmental exposures to environmental chemicals, such as hormonally active substances (endocrine disruptors), may increase the incidence of reproductive abnormalities, metabolic disorders such as diabetes, and cancer, presumably through epigenetic mechanisms that do not involve changes to DNA sequences but which may, nevertheless, be heritable.”[60] Of great concern are adverse neurological outcomes to the developing brain of the fetus from maternal exposure to fire retardant chemicals as has been documented in a series of animal experiments.[34 41 42] Further investigation is needed of the finding that some chemical exposures to endocrine disruption chemicals in animals during pregnancy can lead to heritable changes that continue to have adverse impacts upon future generations. [61]

House cats share our indoor environment and have much higher levels of PBDEs in their blood than do humans.[62] Hyperthyroidism is a new disease that emerged in cats in the 1980s as PBDEs began to be used in significant quantities and is now the second most common disease in cats.[63] Noting that pentaBDE is structurally similar to thyroid hormone, researchers have suggested an association of the high levels of PBDEs in cats and hyperthyroidism. [53]

Other factors to consider are occupational exposures that may occur during the production of BFRs and CFRs; during the manufacture of products containing these chemicals; when firefighters are exposed to toxic products released during combustion; and during waste disposal of such products.[27] [64]

Unlike many other pollutants, BFR and CFR exposures come primarily from contact with consumer products containing BFRs and CFRs, such as electronic appliances, and furniture in the home and office, rather than from diet. The major route of exposure is ingestion of dust with BFRs attached to dust particles.[65] Dust is also the major source of exposure for young children.[66] Preliminary studies suggest that children have greater body burdens than adults.[67] [68] Homes and work environments with several consumer electronic devices have been shown to have higher concentrations of BFRs in indoor air than those without electronics.[69] [70] [71]

Dozens of scientific studies are under way looking at the relationship of other fire retardant chemicals to birth defects, autism, hyperactivity, reduced fertility and sperm counts and other neurological and reproductive conditions. A study at Copenhagen University Hospital associated cryptorchidism, a condition in which one or both testicles fail to descend into the scrotum, with higher concentrations of PBDEs in breast milk.[72] In 2006, Swedish research suggested a link between early-onset testicular cancer and higher levels of maternal PBDEs.[73] The PBDE-autism connection is being studied by Irva Hertz-Picciotto at the Mind Institute at UC Davis.

The continued failure to adequately evaluate the health and environmental hazards of a series of fire retardant chemicals prior to their entering the environment demonstrates the need for a more systematic approach to chemical regulation.

The benefits of additional requirements leading to fire retardant chemicals in electronics should be weighed against the health and environmental costs before proceeding to adopt Clause 7 of IEC 62638, as well as similar candle fire retardancy requirements listed in Appendix 3 and proposed to UL and CSA.

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Section IV: Chemical Industry Involvement in the IEC Process

The proposed candle resistance flammability standard requirement, while protecting against a very small number of fires, would lead to a massive infusion of fire retardant chemicals into consumer electronics, as well as substantial profits for the fire retardant chemical manufacturers. Most of the impetus for Clause 7 of IEC 62368 and other open flame standards in consumer products comes from the chemical manufacturers, their lobbyist Peter Sparber, the NASFM, and other individuals and organizations associated with the chemical industry or Sparber.[74] [75] [76] [77]

According to a recent article in the Washington Post,[78] "Peter Sparber…a vice president of the Tobacco Institute, the industry's lobbying arm, in the 1980s….built a national network of tobacco-friendly fire marshals to call on in the fight against fire-safe cigarettes. …By the late 1980s, Sparber …was a volunteer lobbyist for the National Association of State Fire Marshals….Sparber was still on the tobacco industry payroll."

As discussed previously,[11] starting in 1999, lobbying registration records show, Sparber went to work for the producers of BFRs, which include Chemtura, based in Middlebury, CT, and Albemarle, based in Richmond, VA. Their industry stands to benefit greatly if a candle requirement is implemented for consumer electronics.

Studies from individuals associated with Peter Sparber, the NASFM, and the fire retardant chemical industry provide much of the original justification for Clause 7 and other open flame standards for electronic housings. For example, M. De Poortere and Margaret Simonson carried the research on the high level of TV fires in Europe (based on one fire-prone suburb of Stockholm) that was a primary motivation for the Clause. M. De Poortere is referenced as working for Albermarle S. A. in Belgium.[15] Margaret Simonson has been chair of the Science Advisory Committee of the NASFM. Along with Karen Suhr, who works in Peter Sparber's Washington, DC lobbying firm and also worked with him at the Tobacco Institute, Simonson is the contact person for the International Consortium for Fire Safety, Health and the Environment (ICFSHE).[79]

Including representation from the fire retardant chemical industry in the decision-making process for Clause 7 of the IEC standard should not pose a problem. However, this should be balanced by the inclusion of independent environmental and health scientists in the evaluation of the impacts of the clause. The SFRG committee did not have this balance in its participants.[13]

Peter Sparber continues to serve as the pro bono legislative representative for the NASFM and to coordinate their campaigns for open flame standards, and other regulations that lead to higher levels of fire retardant chemicals in consumer products. A recent NASFM proposal, voted down by the Fire Codes Section of the International Codes Council in February 2008, sought to remove sprinkler exclusions and require in their place high levels of fire retardant chemicals in furniture in nursing homes, hospitals, college dorms, and other residential facilities in the United States.

Another NASFM effort to increase the use of flame retardant chemicals is their petition to the National Transportation Safety Board (NTSB) to classify furniture without a high level of chemicals as a hazardous material. Trucks delivering such furniture would be required to display an orange hazardous materials decal, the drivers would need Hazmat certification, and stores with such furniture would be classified as “hazardous occupancies.”

Consumer product companies report that NASFM uses aggressive tactics to encourage their use of flame-retardant chemicals. For example, the NASFM had a media campaign featuring burning furniture and burn victims to encourage furniture and foam companies to voluntarily follow an open flame standard for furniture required only in California.[80] This standard would have led to a high level of fire retardant chemicals in furniture foam although a relationship between these chemicals and a diminished death rate from furniture fires has not been established in California after 25 years of an open flame standard for furniture foam.[81]

Tactics such as these can push companies into adding fire retardant chemicals to their products without an accurate evaluation of either the fire safety benefit nor the negative impact on human health and the global environment.

Conclusion

Adopting the requirement that all electronic housings be resistant to a three-minute exposure to a candle flame defined in the IEC, CENELEC, UL, and CSA standards is not aligned with current larger issues of public health and the environmental goals of increasing recycling and reducing pollution.

The Special Fire Research Group (SFRG) of TC108 final report in 2003 (See Appendix 2) did not adequately investigate health and environmental concerns nor conclude that fire protection from small open flame fires was a priority. Furthermore, the SFRG did not contain significant representation of scientists with health or environmental expertise.

Prior to 2003, there were a very small number of candle ignitions in consumer electronics in the U.S. The standard was introduced to stop possible future fires. However since that time, the number of fires from candles igniting consumer electronics in the U. S. has remained very small. Before proceeding with a requirement such a standard, current fire data and trends from the E.U. and internationally for small open flame ignitions in electronics must also be determined and evaluated to see if there is a fire safety rationale for this requirement.

Although the developers of the candle flame resistance requirement point out that the standard does not dictate the method to be used to meet the requirement, the most likely approach would be to add flame retarding chemicals to current materials. Including a variety of fire retardant chemicals in plastic housings will increase the cost and complexity of recycling, and potentially shift waste material into energy recovery (burning), where unknown and potentially dangerous combustion byproducts will be released into the environment for years to come.

The possible adverse impact of open flame standards on public health and the environment is enormous. The chemicals likely to be used as flame retardants include known human and environmental toxicants or those for which we do not have adequate health or toxicity information.

While flame retardant plastic housings can help with small open flame ignition, they will ignite and burn from a larger flame source, such as a wastebasket fire. Sprinkler systems stop nearly all fires without imperiling human heath and the environment. Other effective strategies to reduce fire deaths and injuries include the redesign of products to minimize flammability, as well as smoke detectors, fire safe cigarettes and candles. A most effective way to reduce fire deaths is through campaigns to reduce smoking.

This paper demonstrates the lack of a documented past or present fire safety rationale for open flame standards for electronic housings and enormous potential negative consequences to the health of humans, animals, and the environment

Sales of the fire retardant chemicals to meet this standard will provide billions of dollars of revenues to the chemical industry which is influencing the IEC process to its own profit. The cost to the world in adverse impacts on human health and the environment is likely to be orders of magnitude greater.

In a similar decision last year, the US Consumer Product Safety Commission decided to not to move forward with an open flame standard for furniture. Their decision was based in part on health and environmental concerns about the fire retardant chemicals likely to be used to meet the standard. **CPSC Commissioner Moore said "No one wants to trade fire risks for chemical toxicity risks."**

The fire retardant chemical industry has a history of **not** providing adequate toxicological information in advance of sales of its products. Polybrominated biphenyls (PBBs), polychlorinated biphenyls (PCBs), Tris, Halon, asbestos, and PBDEs are all fire retardant materials which have turned out to have serious long-term negative effects on our health and/or environment only after extensive use.

Once toxic fire retardant materials such as these enter the global environment, it is impossible to recall them. Bioaccumulation and adverse health impacts of many of these fire retardant materials in multiple animal species are well documented. Similar outcomes are beginning to be seen in humans.

In the U.S., ineffective toxics regulation means that neither the federal nor state environmental protection agencies nor other governmental organizations have the authority to require manufacturers to provide the necessary health and safety information to ensure fire retardant chemicals are safe for human health.

Whether the fire retardants to be used are BFRs, CFRs, phosphates, or other alternatives, adding hundreds of thousands of tons of such chemicals to consumer products without adequate health information represents an enormous gamble with human and environmental health worldwide. Adding these chemicals without a strong fire safety rationale is not a responsible course of action.

There is a vast amount of new information including fire, health, and environmental data that needs to be considered before any open flame standards for electronic housings are promulgated. Any such evaluation should be carried out by teams that include impartial academics and NGOs with environmental and health expertise as well as representatives from the electronics industry and the fire retardant chemical industry.

Fire-retardant chemicals in our homes should not pose a much greater hazard to our health and environment than the risk of the fires they are supposed to prevent. USTAG has voted no to the candle flame requirements contained in clause 7 of the draft IEC 62368 standard till environmental studies are conducted to determine its impact. It is critical that 1/3 or more of the national bodies that belong to the IEC TC 108 committee **vote "No" on IEC standard 62368 with the added comment to delete 7 in its entirety and also vote "No" on adding a candle resistance requirement to IEC 60950-1 and IEC 60065.**

The three candle resistance standards are currently under parallel vote in CENELEC as prEN 62368, EN 60065, pr A11 and EN 60950-1. We also ask CENELEC to vote "No" on all three standards to protect human health and the global environment. (The three CENELEC safety standards, mirror IEC standards, and their expected effective dates can be found in Appendix 3.)

Finally Underwriters Laboratory and the Canadian Standards Association should vote "No" to a similar amendment to UL/CSA Bi-national standard UL60950-1 and CSA C22.2 no. 60950-1, 2nd edition that has been proposed by the NASFM and is due for balloting on May 19, 2008.

Appendices

Appendix 1: Major Documents used in Support of the Candle Flame Ignition Requirement, Clause 7 of IEC 62368

NASFM based the need for IEC 62368 primarily on four documents. [13] [82] [83] [84]
In order to justify the IEC proposal, NASFM should show that there are enough electronics fires, of enough severity, to constitute a real danger to the consumer. Two basic questions should be answered:

1. How many destructive fires occur each year due to candle igniting the external housing of electronics?
2. Would less flammable enclosures reduce fire deaths, injuries, and/or losses?

These answers are necessary given the toxicity and high economic costs (compliance costs, health costs, environmental costs, and cost of losing the opportunity to recycle) of implementing Clause 7 of the proposed IEC standard.
Neither of these questions has been adequately answered in these documents.

Document 1 is a website with links to sub-documents associated with NASFM meetings in 2002. Few of the sub-documents are original reports or are well referenced. There are three Powerpoint presentations, a set of meeting notes, a letter against the IEC standard from the CEA, and a call for information regarding the standard.

Document 2 attempts to answer questions about the prevalence and severity of electronics fires in the United States and Europe. Based on equivocal information, the report concludes that there is a significant need for higher fire safety in Europe, and a somewhat lesser need in the US. However the thoroughness of the report and the conclusions drawn from data are open to question.

Document 3 compares the flammability of four types of resins (ABS, HIPS high, PC, and PP) and three categories of flame retardancy (inherent in the plastic with no additives, with halogen free additives, and with brominated/antimony flame retardants). The report scientifically details heat outputs of the various materials. The report concludes that, with flame retardants (halogenated or otherwise), there is little chance of a candle ignited electronics fire that would spread throughout a structure, while without flame retardants, electronics have the capacity to ignite and spread fire. However, the report does not address the incidence of such fires.

Document 4 is a study by John Hoffman of the Safety Engineers Laboratory in Michigan. It finds that V0 plastics are less flammable than HB plastics and that it is difficult to tell whether a TV fire starts internally or externally based on the burn pattern of the room. Although it is not the main thrust of the paper, the author suggests that V0 plastics are the reason for the decline of TV fires in the US from 1980 to 1997. However, the paper makes this claim without discussing other possible reasons for the decrease in fires (better internal electronics, better open flame safety in the home, etc.), nor does it give a quantitative estimate of the increase in V0 plastics in the American market.

Appendix 2: Response of the IEC Special Fire Research Group to Proposal for a Candle Flame Resistance Requirement Report

After receiving the NASFM proposal for an open flame standard for electronic housings, the IEC created a Special Fire Research Group (SFRG) to assess the probability of fires caused by open flames external to consumer electronics housing; conditions that might cause these fires; and also the environmental implications of addition of flame retardant chemicals to electronics housing over the intended lifecycle of the product.

The summary conclusions of the SFRG report,[13] as quoted below, concluded that more study was needed.

> *a. How large is the fire problem associated with the equipment of interest?*
> There is sufficient historical evidence of fire experience involving entertainment and electronic equipment to justify a more detailed examination. The TV fire rate in Europe is significantly higher than the U.S. rate. It is less clear how the fire death rates compare, and it is not clear how the fire incidence rates compare for equipment of interest other than TVs.
>
> *b. How much of the fire problem involving the equipment of interest arises from external ignition?*
> Internal ignition accounts for most fires and should be the primary concern of any fire safety initiative, but external ignition contributes a sufficient share to justify further examination.
>
> *c. What is the severity of the fires involving the equipment of interest?*
> Fires involving this equipment tend to be smaller than typical structure fires in both Europe and the U.S.
>
> *d. What are the sources of external ignitions?*
> For the particular types of equipment of interest, open flame is the principal type of external ignition, and most open flame ignitions that are not the result of a fire started somewhere else in a room or building are due to candles.
>
> *e. What is the role of intentional fire setting and fire play by children in the open flame ignitions of appliance housings?*
> For the dominant open-flame source (i.e., candles), intentional and child-play fires is not an issue. For match and lighter ignitions of appliance housings, intentional fire setting accounts for the majority of fires, while child-playing is much less an issue.
>
> *f. What does the fire record of the U.S. vs. Europe imply about the fire performance of V0 plastic?*
> The greater use of V0 plastic may explain the large difference in TV fire incidence rates between Europe and the U.S. There is no clear, comparable difference in average fire severity, which is low for these fires in both regions."

Appendix 3: Proposed Product Safety Standards from the IEC and CENELEC and their Expected Effective Dates

Standard	Expected Publication date	Expected Effective date	Applicable to
IEC 60065, Amendment 2	September 2008		All TVs including plasma TVs
EN 60065, pr A11	December 2008	December 1, 2010	All TVs including plasma TVs
IEC 60950-1, Amendment 1			All products for home use under the scope of IEC 60950-1 Monitor, personnel computer Printer, scanner, fax machine, copier, calculator Photo-printing equipment for home use Monetary processing machines for home use Telephone sets, pager, modem
EN 60950-1 Amendment no. not assigned yet	December 2008	December 1, 2011	All products for home use under the scope of IEC 60950-1 Monitor, personnel computer Printer, scanner, fax machine, copier, calculator Photo-printing equipment for home use Monetary processing machines for home use Telephone sets, pager, modem
IEC 62368	September 2008	-	All products for home use in the scope of IEC 62368 Monitor, personnel computer Printer, scanner, fax machine, copier, calculator Photo-printing equipment for home use Monetary processing machines for home use Telephone sets, pager, modem Audio, CD/DVD players, satellite receivers Game machines Video cameras Electronic musical instruments.
EN 62368	December 2008	December 2013	All products for home use in the scope of IEC 62368 All TVs including plasma TVs Monitor, personnel computer Printer, scanner, fax machine, copier, calculator Photo-printing equipment for home use Monetary processing machines for home use Telephone sets, pager, modem Audio, CD/DVD players, satellite receivers Game machines Video cameras Electronic musical instruments.

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(Organizations are in the U.S. unless otherwise specified.)

36ZeroWaste Group, Inc. (Canada)
AAMMA - Asociacion Argentina de Medicos por el Medio Ambeinte (Argentina)
AKUT - Information and Advice Centre for Pollutant Loads (Luxembourg)
APROMAC - Environment Protection Association (Brazil)
ARTAC - Association for Research on Treatments Against Cancer (France)
AWHHE (Armenian Women for Health and Healthy Environment)
BANANAS Child Care & Family Support Agency
Basel Action Network
Bellona Europa aisbl
BlueVoice
Breast Cancer Action
Breast Cancer Fund
CATs - Communities Against Toxics (Scotland)
CEPTA - Centre for Sustainable Alternatives (Slovak Republic)
CIEL - Center for International Environmental Law
Canadian Environmental Law Association
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Center for Environmental Oncology of the University of Pittsburgh Cancer Institute
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Health and Environment Alliance (Europe)
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Hospital Fire Marshals'Association, Inc.
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Initiative Liewensufank, Pregnancy, Childbirth and Parenting Centre (Luxembourg)
Institute for Zero Waste in Africa (South Africa)
Institute of Green Oxidation Chemistry, Carnegie Mellon University
Inter-Environnement Wallonie (Belgium)
International Chemical Secretariat (Europe)
Irish Doctors' Environmental Association (Ireland)
ISDE - International Society Doctors for the Environment (Austria)
ISTAS (Spanish Union Institute of Work, Environment and Health)
JA! Justica Ambiental (Mozambique)
The Lands Council (Canada)
MGM The Foundation Reporting Health and Environment (Meldpunt Gezondheid en Milieu, The Netherlands)
MOMS(Making Our Milk Safe)
Moms Rising
Mother Earth Foundation (Philippines)

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Oregon Toxics Alliance
Pacific Environment-China
Parents for a Safer Environment
Planning and Conservation League
Public Trust Alliance
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Quercus (Portugal)
Rainforest Action Network
SNF – Society for Sustainable Living (Czech Republic)
SSNC – Swedish Society for Nature Conservation (Sweden)
Sierra Club
Silicon Valley Toxics Coalition
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Endnotes

[1] Please bring any wording or footnoting errors to our attention. This paper was prepared in a short amount of time with little staff support because our participation began late in the IEC process. However, we are confident that this paper is accurate with respect to its substance.

[2] With thanks to Jim Barber, Peter Brigham, Erin Conlisk, Susan Kegley, Ann Stein, Carolyn Said, and many others who contributed to the text and/or editing of this report.

[3] Approximately 1/3 of electronic housings are currently treated with fire retardant chemicals. The annual increase with the IEC candle resistance requirement is estimated to be twice the current usage. Estimates of the increase if Clause 7 of the IEC standard were to be enacted range from a low of 250,000 metric tons (550 million pounds) of BFRs to a high of 790,000 metric tons (1.7 billion pounds) in total

[4] Hall, John R. 2002. Fires involving appliance housings – is there a clear and present danger? Fire Technology 38: 179-198

.

[5] Ahrens, M. 2007. National Fire Protection Association Report on Home Candle Fires.

[6] Dave Wilson, October 1 2002, Electronic Equipment Ignition By Candle – Recent Incident Reports, Consumer Electronics Association

[7] Furniture Flame Retardancy Partnership: Environmental Profiles of Chemical Flame-Retardant Alternatives for Low-Density Polyurethane Foam, EPA 742-R-05-002A, September 2005

[8] Zota AR, Rudel RA, Morello-Frosch RA, Camann DE, Brody JG. 2007. Regional variation in levels of indoor polybrominated diphenyl ethers may reflect differences in fire safety regulations for consumer products. 17th Annual Conference of the International Society of Exposure Analysis, Research Triangle Park, NC.

[9] Forum Summary Report, "Forum on Potential External Ignition of Information Technology Equipment,"' The Information Technology Council and the National Fire Protection Association. March 30, 2000, Washington DC.

[10] See the proposal on the archived NASFM web site at: http://66.151.177.220/issues/home/computer_fires.html, under “NASFM Proposals to Underwriters Laboratories Standards Technical Panels for Audio, Video, and Similar Electronic Apparatus (UL 60065) and Information Technology Equipment (UL 60950)”

[11] (http://www.encyclopedia.com/printable.aspx?id=1G1:88576710)
CPSC Monitor | Date: 1/1/2001, State Fire Marshals endorse Gall for CPSC Chairman

[12] Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal**,** Eighth meeting, Nairobi, 27 November–1 December 2006
Item 4 of the provisional agenda, Organization of the meeting. Creating innovative solutions through the Basel Convention.

[13] Study on the ignition of ICT and Audio/Video equipment by external ignition sources, Report of the International Electotechnical Commission’s Technical Committee 108 Special Fire Research Group document TC 108/AGS/SFRG (Report/chairman)1, 2003-09-20.

[14] Simonson, Margaret, Claes Tullin, Hakan Stripple. 2002. Fire-LCA study of TV sets with V0 and HB enclosure material. *Chemosphere*. 46: 737-744.

[15] De Poortere, M. Shonbach, C. and Simonson, M. 2000. The fire safety of TV set enclosure materials, a survey of European statistics. *Fire and Materials*. 24: 53-60.

[16] Causes of Fire Involving Television Sets In Dwellings. April 2001. UK Department of Trade and Industry.

[17] TR41.7 Comments on the Proposal for Adding Candle Flame Test to UL 60950-1, March 31, 2005.

[18] TR41.7 letter to UL Objecting to the Preliminary Proposal for Candle Flame Requirements UL 60950-1, December 14, 2007.

[19] ASTM F2417-04 in the U.S. and EN 15493 of 2007 in the EU are the standards for candle safety.

[20] Characterization of Plastics from Minnesota's Demonstration Project for the Recovery of End-of-Life Electronics," Minnesota Office of Environmental Assistance and Partners, 2000.

[21] Dawson, Landry, "Recyclability of Flame Retardant HIPS, PC/ABS, and PPO/HIPS used in Electrical and Electronic Equipment." ISEE, 2005.

[22] Mark, F. The characteristics of plastics-rich waste streams from end-of-life electrical and electronic equipment. Plastics Europe, 2006.

[23] APME, Plastics Market 2004

[24] Tange, L., Drohmann, D. "Waste electrical and electronic equipment plastics with brominated flame retardants – from legislation to separate treatment – thermal processes." Polymer Degradation and Stability 88 (2005), pp 35 – 40.

[25] Vehlow, J. et al. Recycling of bromine from plastics containing brominated flame retardants in state-of-the-art combustion facilities. Technical paper by APME, 2002.

[26] Leung A, Cai ZW, Wong MH. 2006. Environmental contamination from electronic waste recycling at Guiyu, southeast China. Journal of Material Cycles and Waste Management 8(1): 21-33.

[27] Bi X, Thomas Go, Jones KC, Qu W, Sheng G, Martin FL, et al. 2007. Exposure of electronics dismantling workers to polybrominated diphenyl ethers, polychlorinated biphenyls, and organochlorine pesticides in South China. Environ Sci Technol 41(16): 5647-5653.

[28] Deng WJ, Louie PKK, Liu WK, Bi XH, Fu JM, Wong MH. 2006. Atmospheric levels and cytotoxicity of PAHs and heavy metals in TSP and PM2.5 at an electronic waste recycling site in southeast China. Atmospheric Environment 40(36): 6945-6955.

[29] http://www.news.com.au/story/0,23599,23087523-421,00.html and http://www.panda.org/about_wwf/where_we_work/europe/what_we_do/arctic/news/index.cfm?uNewsID=13399

[30] Zota AR, Rudel RA, Morello-Frosch RA, Camann DE, Brody JG. 2007. Regional variation in levels of indoor polybrominated diphenyl ethers may reflect differences in fire safety regulations for consumer products. 17th Annual Conference of the International Society of Exposure Analysis, Research Triangle Park, NC.

[31] Schecter M.P.Vuk, O. Papke, J.J. Ryan, L. Birnbaum, R. Rosen,, *Polybrominated diphenyl ethers (PBDEs) in US mothers' milk*. Environmental Health Perspectives**,** 111, (14), 1723-1729(2003).

S. Lunder, R. Sharp, *Mothers' Milk: Record levels of toxic fire retardants found in American mothers' breast milk*. Environmental Working Group. www.ewg.org/reports/mothersmilk/ (2003)

She J. et al. 2007. *Polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs) in breast milk from the Pacific Northwest*. Chemosphere, 2007 Apr;67(9):S307-17 .

N. Wu, T. Herrmann, et al. *"Human exposure to PBDEs: associations of PBDE body burdens with food consumption and house dust concentrations."* Environmental Science and Technology 41(5): 1584-9(2007*).*

Eslami, B. et al. 2006. *Large-scale evaluation of the current level of polybrominated diphenyl ethers (PBDEs) in breast milk from 13 regions of Japan.* Chemosphere, 63 (4): 554-61.

Jaraczewska, K., J. Lulek, A. Covaci. et al. 2006. *Distribution of polychlorinated biphenals, organochlorine pesticides and polybrominated diphenyl ethers in human umbilical cord serum, maternal serum and milk from Wielkopolska region, Poland.* Sci Total Environ, 372 (1): 20-31.

Lind Y. et al. 2003. P*olybrominated diphenyl ethers in breast milk from Uppsala County, Sweden.* Environ Res. 2003 Oct; 93(2):186-94.

[32] Linda S. Birnbaum and Elaine A. Cohen Hubal, Brominated flame-retardants: Cause for concern? Environmental Health Perspectives, Volume 112(2004).

[33] P. Eriksson, E. Jakobsson, A. Fredriksson, Brominated flame-retardants: a novel class of developmental neurotoxicants in our environment? Environmental Health Perspectives, Volume 109, No. 9, pp 903-908(2001).

[34] Henrik Viberg, Anders Fredriksson, et. al, Neurobehavioral derangement in adult mice receiving decabrominated diphenyl ether (PBDE 209) during a defined period of neonatal brain development, Toxicological Sciences, Volume 76, pp 112-120(2003).

[35] M. Babich, “CPSC staff preliminary risk assessment of flame retardant (FR) chemicals in upholstered furniture foam” (U.S. Consumer Product Safety Commission, Bethesda, MD,

[36] Morris /et al/. 2004. Distribution and fate of HBCD and TBBPA brominated flame retardants in North Sea Estuaries and aquatic food webs. Environ. Sci. Technol. 38:5497-5504

[37] Brown FR, Winkler J, Visita P, Dhaliwal J, Petreas M. 2006. Levels of PBDEs, PCDDs, PCDFs, and coplanar PCBs in edible fish from California coastal waters. Chemosphere 64(2): 276-286.

[38] Berger /et al/. 2004. Two trace analytical methods for determination of hydroxylated PCBs and other halogenated phenolic compounds in eggs from Norwegian birds of prey. Anal. Chem. 76: 441-452.

[39] Hooper K, Holden A, Chun C, Linthicum J, Walton B. 2007b. “Terrestrial” vs. “Aquatic” Food Webs: High BDE-209 Levels in Peregrine Falcon Eggs from California. . Organohalogen Compd 69: 2715-2718.

[40] Jakobsson K, Thuresson K, Rylander L, Sjodin A, Hagmar L, Bergman A. 2002. Exposure to polybrominated diphenyl ethers and tetrabromobisphenol A among computer technicians. Chemosphere 46:709–716

[41]Viberg H, Johansson N, Fredriksson A, Eriksson J, Marsh G, Eriksson P., Neonatal exposure to higher brominated diphenyl ethers, hepta-, octa-, or nonabromodiphenyl ether, impairs spontaneous behavior and learning and memory functions of adult mice. Toxicology Sci. Volume 92, No. 1, pp.211-8. (2006)

[42] Viberg H, Frredriksson A, Eriksson P. Neonatal exposure to the brominated flame retardant 2,2',4,4',5-pentabromodiphenyl ether causes altered susceptibility in the cholinergic transmitter system in the adult mouse. Toxicology Sci. Volume 67, No.1, pp.104-107 (2002).

[43] Zhou T, Ross DG, DeVito MJ, Crofton KM. Effects of short-term in vivo exposure to polybrominated diphenyl ethers on thyroid hormones and hepatic enzyme activities in weanling rats. Toxicol Sci. Volume 61(1):76-82. 2001.

[44] Zhou T, Taylor MM, Vito MJ, Crofton KM. Developmental exposure to brominated diphenyl ethers results in thyroid hormone disruption, Toxicol Sci. 2002 Mar;66(1):105-16.

[45] NTP (1986). Toxicology and Carcinogenesis Studies of Decabromodiphenyl Oxide (CAS No. 1163-19-5) in F344/N Rats and B6C3F1 Mice (Feed Studies). NTP Technical Report No. 309. National Toxicology Program. . U.S. Department of Health and Human Services. Public Health Service National Institutes of Health. NIH Publication No. 86-2565.

[46] Stapleton HM, Brominated Flame Retardants: Summary of Scientific Studies on Accumulation and Debromination of DecaBDE, 11 December 2006, Health and environment Alliance, Brussels, Belgium

[47] <http://europa.eu/rapid/pressReleasesAction.do?reference=MEX/08/0409> (sixth bullet).

[48] NTP (2008) http://ntp.niehs.nih.gov/?objectid=BD5EA5A9-123F-7908-7B9B7C4D3356C1CF

[49] LS Birnbaum, DF Staskal, JJ Diliberto , September 2003, Health effects of polybrominated dibenzo-p-dioxins (PBDDs) and dibenzofurans (PBDFs) - Environment International, Volume 29, Number 6, pp. 855-860(6)

[50] Kester MH, Bulduk S, van Toor H, Tibboel D, Meinl W, Glatt H, Falany CN, Coughtrie MW, Schuur AG, Brouwer A, Visser TJ. Potent inhibition of estrogen sulfotransferase by hydroxylated metabolites of polyhalogenated aromatic hydrocarbons reveals alternative mechanism for estrogenic activity of endocrine disrupters. J Clin Endocrinol Metab. 2002 Mar;87(3):1142-50.

[51] Hamers T, Kamstra JH, Sonneveld E, Murk AJ, Kester MH, Andersson PL, Legler J, Brouwer A. In vitro profiling of the endocrine-disrupting potency of brominated flame retardants. Toxicol Sci. 2006 Jul;92(1):157-73.

[52] Kitamura S, Suzuki T, Sanoh S, Kohta R, Jinno N, Sugihara K, Yoshihara S, Fujimoto N, Watanabe H, Ohta S. *Compa ative study of the endocrine-disrupting activity of bisphenol A and 19 related compounds.* Toxicol Sci. 2005 Apr;84(2):249-59. Epub 2005 Jan 5

[53] Van der Ven LT, Van de Kuil T, Verhoef A, Verwer CM, Lilienthal H, Leonards PE, Schauer UM, Cantón RF, Litens S, De Jong FH, Visser TJ, Dekant W, Stern N, Håkansson H, Slob W, Van den Berg M, Vos JG, Piersma AH. Endocrine effects of tetrabromobisphenol-A (TBBPA) in Wistar rats as tested in a one-generation reproduction study and a subacute toxicity study. Toxicology. 2008 Mar 12;245(1-2):76-89.

[54] M.M. Schantz, S.A. Wise, Polybrominated diphenyl ethers in house dust and clothes dryer lint. Environmental Science and Technology**,** 39, (4), 925-931(2005).

[55]Arnold Schecter, Olaf Päpke, T. Robert Harris, K.C. Tung, Alice Musumba, James Olson, and Linda Birnbaum, Polybrominated Diphenyl Ether (PBDE) Levels in an Expanded Market Basket Survey of U.S. Food and Estimated PBDE Dietary Intake by Age and Sex, Environmental Health Perspectives • Volume 114, Number 10(October 2006)

[56] Thomas A. McDonald, *Polybrominated Diphenylether Levels among United States Residents: Daily Intake and Risk of Harm to the Developing Brain and Reproductive Organs*, Integrated Environmental Assessment and Management, Volume 1, Number 4, pp. 343–354

[57] Gill U, Chu I, Ryan JJ, Feeley M. Polybrominated diphenyl ethers: human tissue levels and toxicology. Rev Environ Contam Toxico 183:55-97(2004).

[58] Colborn, T Environ Health Perspect. 2004 Jun;112(9):944-9. Neurodevelopment and endocrine disruption.

[59] Birnbaum LS, Staskal DF, Environ Health Perspect. 2004 Jan; 112(1):9-17.
Brominated flame retardants: cause for concern?

[60] Grandjean, P et al. The Faroes Statement: Human Health Effects of Developmental Exposure to Chemicals in our Environment." Basic Clin Pharmacol Toxicol. 2008 Feb;102(2):73-5)

[61] Anway MD, Cupp AS, Uzumcu M, Skinner MK. Epigenetic transgenerational actions of endocrine disruptors and male fertility. Science. 2005 Jun 3;308(5727):1466-9

[62] Dye, J.A.; Venier, M.; Ward, C.R.; Zhu, L.Y.; Hites, R.A.; Birnbaum, L.S.; Pet cats in the U.S. have high polybrominated diphenyl ether (PBDE) serum levels. Environ. Sci. Technol. 2007, 41, 6350-6356

[63] D. C. Ferguson, The Pathogenesis of Feline Hyperthyroidism, 16th ECVIM-CA Congress, 2006. Charlene Edinboro (et al.) The epidemiology of hyperthyroidism, Journal of the American Veterinary Medical Association, 2004 Mar 15; 224(6):879-86)

[64] Hale RC, La Guardia MJ. 2002. Synthetic organic pollutants in land-applied sewage sludges. The Scientific World Journal 1(Cited April 1, 2002): 10-13.

[65] M. Lorber, J. Exposure Sci. Environ. Epidemiol., published online 11 April 2007 (PMID: 17426733).
[66] Jones-Otazo HA, Clarke JP, Diamond ML, Archbold JA, Ferguson G, Harner T, et al. 2005. Is house dust the missing exposure pathway for PBDEs? An analysis of the urban fate and human exposure to PBDEs. Environmental science & technology 39(14): 5121-5130.

[67] Thomsen C, E L, G B. 2002. Brominated flame retardants in archived serum samples from Norway: a study on temporal trends and the role of age. Environ Sci Technol 36: 1414-1418.

[68] Fischer D, Hooper K, Athanasiadou M, Bergman Å. 2006. Children Show Highest Levels of Polybrominated Diphenyl Ethers (PBDEs) in a California Family of Four – A Case Study. Environmental Health Perspectives 114: 1581-1584.

[69] Harrad S, Hazrati S, al. e. 2006. Concentrations of Polychlorinated Biphenyls in Indoor Air and Polybrominated Diphenyl Ethers in Indoor Air and Dust in Birmingham, United Kingdom: Implications for Human Exposure. Environmental Science & Technology 40(15): 4633-4638.

[70] Jakobsson K, Thuresson K, Rylander L, Sjodin A, Hagmar L, Bergman A. 2002. Exposure to polybrominated diphenyl ethers and tetrabromobisphenol A among computer technicians. Chemosphere 46(5): 709-716.

[71] Mandalakis M, Atsarou V, Stephanou E. 2006. Polybrominated diphenyl ethers in outdoor, indoor, and car interior air in Greece. In: American Chemical Society National Meeting and Exposition. San Francisco, CA.

[72] Main, Katharina M, et al. 2007. Flame Retardants in Placenta and Breast Milk and Cryptorchidism in Newborn Boys, In: Environmental Health Perspectives, ehponline.org

[73] Hardnell, L. et al, In Utero Exposure To Persistent Organic Pollutants in Relation to Testicular Cancer Risk, International Journal of Andrology, 29 (2006) 228–234., page. 229

[74] http://web.archive.org/web/19990420072056/www.firemarshals.org/advocate.htm

[75] Conversation with Andrew McGuire, Executive Director, Trauma Foundation, San Francisco General Hospital

[76] Los Angeles Times, Thursday, January 1, 1998, Section: PART A, page: A-1
Big Tobacco's Dollars Douse Push for Fire-Safe Cigarettes; Lobbying: Firms bankroll experts, alliances with safety groups to resist product changes, papers show. By: Myron Levin, Times Staff Writer

[77] E.M. Barbeau, G. Kelder, S. Ahmed, V. Mantuefel and E.D. Balbach, From strange bedfellows to natural allies: the shifting allegiance of fire service organizations in the push for federal fire-safe cigarette legislation, Tobacco Control;14:338-345(2005) and many other articles at http://legacy.library.ucsf.edu

[78] "Fighting for Safety: Your Couch Is Caught in a Flammable Regulatory Battle Between the Chemical and Furniture Industries" By Annys Shin, Washington Post, Saturday, January 26, 2008; Page D01

[79] See http://clean-and-safe.org/contact.htm

[80] http://www.firemarshals.org/mission/residential/fuels-in-the-home/upholstered-furniture/
October 30, 2006 NASFM Press Release: State Fire Marshals Renew Call for Fire-Safe Home Furniture Fire Fighters, Survivors Join Demand for Flammability Standards; Also the Today Show, October 26, 2006

[81] Arlene Blum, The Fire Retardant Dilemma, Science, Vol 318, 12 October 2007, page 194

[82] NASFM Science Advisory Committee, "Recommendations Regarding an External Candle Ignition Standard for Information Technology Equipment and Consumer Electronics."
http://66.151.177.220/issues/home/computer_fires.html

[83] The NIST Technical Note 1461, "Full-Scale Flammability Measures for Electronic Equipment" by Matthew Bundy and Thomas Ohlemiller, National Institute of Standards and Technology (NIST), dated August 2004.

[84] "Television and Electronic Device Burn Demonstrations Product Aftermarket Evaluation," prepared by Safety Engineering Laboratories, Inc. for the Consumer Electronics Association, dated June 2000. Available by request.