



The Case Against Candle Resistant Electronics

(This is an update of a 2008 paper, and as such most of the data are from 2008 or before. Future updates can be found at <http://greensciencepolicy.org/standards.shtml>)

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The proposed conversion of technical specification (TS) 62441 into an IEC and/or a CENELEC standard could bring hundreds of thousands of tons² of potentially toxic flame retardant chemicals into homes, schools, hospitals, businesses, and wherever else electronic equipment is found, without providing a fire safety benefit. Such “candle flame” external ignition resistance requirements threaten human health, the global environment, and the responsible recycling of electronic equipment. Current fire, health, and environmental data must be obtained and evaluated before promulgating the candle flame resistance requirements in IEC 62441/Ed1 and their addition to subsequent amendments of IEC/CENELEC 62368-1 and 60065.

Executive Summary

The text of TS 62441 was developed at a TC108 plenary meeting in Matsue, Japan, in October 2008. On December 19, 2014 the 108/562/CDV for IEC 62441/Ed1 that “safeguards against accidentally caused candle flame ignition” was brought up in parallel at the IEC and CENELEC level for a vote ending March 18, 2015. If TS 62441 is elevated to an IEC or CENELEC standard, new CDVs will come up for vote in 2015 referencing IEC 62441/Ed1 within the text of other IEC/CENELEC standards such as 62368-1 and 60065.

While on the surface these proposed provisions might seem beneficial, this paper will demonstrate that these requirements are not needed for fire safety, and their adoption will adversely impact 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 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.^{3,4} 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.”⁵

The central case used to justify proposed candle resistance 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. [A 2014 paper](#), *The TV fire and flame retardant controversy: deconstructing the data* by Tom Muir, explains in detail the problems with these data.⁶

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 flame retardant

manufacturers and their representatives – companies that stand to gain financially if these standards are adopted.

Proponents of the candle resistance requirements 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.⁷ 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.⁸

Many flame 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 flame retardant chemicals in dust, food, and breast milk than Europe⁹ where flame retardants are less used. The average U.S. woman’s body and breast milk contains flame retardants at levels approaching those that cause adverse reproductive and neurological health problems in animals.¹⁰

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 flame retardant chemical pentaBDE, used primarily in furniture in the U.S., (currently prohibited in the EU and several 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.¹¹

Identifying effective fire retarding materials that also meet health and environmental requirements is difficult. One major BFR and CFR alternative is a class of flame retardants based on phosphorous; however, many of these chemicals have not been studied sufficiently to reasonably define their risks. Most phosphate flame 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 flame 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 flame 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.

Flame 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 for consumer than the additive ones that are not bonded and can migrate out into the environment. However, the hazard of manufacture to workers and those living in the vicinity of the plant as well as the hazard of disposal should also be considered.

Flame 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 flame 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 by these open flame standards is not justified.

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Section I: What Is the Proposed IEC/CENELEC Standard 62441/Ed1?

The proposed IEC Standard 62441 “Safeguards against accidentally caused candle flame ignition” is a test method that does not specify particular products. It is meant to be referenced in other standards such as the IEC/CENELEC 62368-1 and 60065.

What Are the Existing Fire Safety Standards for Electronic Devices?

Electronic products today are designed according to strict safety standards that 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
IEC 62368-1: 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.

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

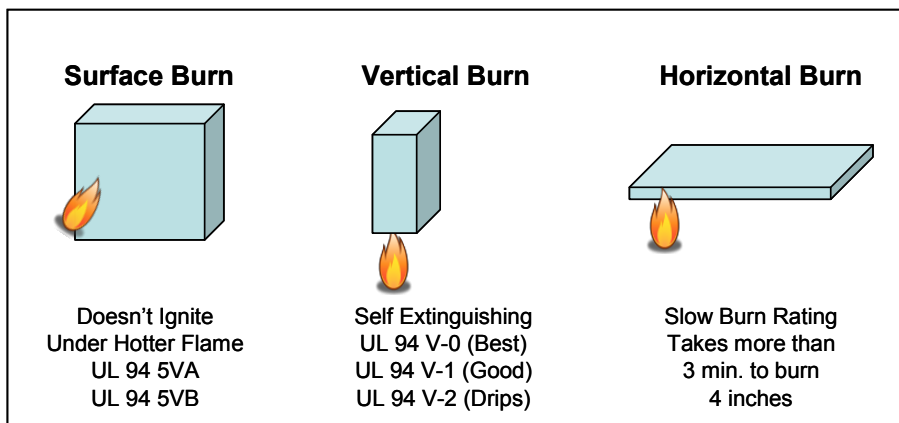
Table 2 below shows the Underwriters Laboratory ratings for flammability of electronic housings. Materials inside electronic appliances currently need to meet minimum flame rating levels (usually V-0), which means they will readily self-extinguish after contact with a vertical flame. They are designed 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 IEC 62441/Ed1 would require the plastic in the outer housing exceeding 300 g 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	<i>More Flame Resistant</i> ↓ <i>Less Flame Resistant</i>
5VB	
V-0	
V-1	
V-2	
HB	

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 62441/Ed1 requires that external housings have a flammability rating of at least V-1.

To meet this requirement, manufacturers are most likely to add flame retarding chemicals to the currently used electronic housing materials, HIPS and ABS. A variety of flame retardants can and will be used to comply with the IEC standard. The flame 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, used to be most often flame retarded with decabromodiphenyl ether (decaBDE). Although decaBDE is being phased out, the numerous replacements are from the same family and lack adequate information. According to EFRA¹² there are a series of brominated replacements. In virgin HIPS, the currently most widely used flame retardant additives for the manufacture of electronic cabinets and enclosures are:

- Ethane bis(pentabromophenyl) (EBP),
- Tris(tribromophenoxy)triazine (TTBPT) and
- Ethylene bis(tetrabromophthalimide) (EBTBP) in combination with metal oxide synergists (typically antimony oxide).

In ABS:

- Tetrabromobisphenol-A (TBBPA),
- Tris(tribromophenoxy)triazine (TTBPT),
- Brominated Epoxy oligomers/polymers with or without end capping (BEOs, BEs and MBEOs), and
- Ethane bis(pentabromophenyl) (EBP) or Brominated Carbonate Oligomers (BCOs), in combination with metal oxide synergists, are the most common flame retardant additives for the manufacture of enclosures.

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 IEC 62441/Ed1 candle requirement is enacted.

Currently 45% of the flame 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.

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

Table 3. Estimated TV Flame Retardants Cost to Meet the V-1 Standard (as of 2008)

Flame 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 Standards

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 flame 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.¹³

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. The impetus and momentum motivating the candle standard continued to come from NASFM for some years. Four documents, cited by NASFM as justifying the standard in its proposal,¹⁴ 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.¹⁵ As discussed in more detail in Clause IV, Peter Sparber was the founder of the NASFM and his lobbying organization continued to be their liaison to the government and the CPSC.¹⁶ The fact that Sparber was a long-time a paid lobbyist for the flame retardant chemical producers suggests the NASFM is not an impartial party. Sparber and the NASFM have long been connected to an industry that will gain a substantial financial benefit from the adoption of open flame standards for electronic housings. Sparber retired a few years ago.

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 no hazard.³

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.¹⁷ 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.¹⁸ 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,¹⁹ 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 meet 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 IEC 62441/Ed1 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 flame retardants such as those currently used to fire retard plastic enclosures of consumer IT and audio / video equipment.

What Is the Risk Of Candle Ignition For Consumer Electronics?

Proposals for flammability standards for plastic housings around television (TV) and other electronic equipment often cite papers by Margaret Simonson and colleagues^{20,21,22} showing a large fire-safety benefit from the use of flame retardant chemicals in TV enclosures. Her

estimate comes from a paper by de Poortere *et al.*²³ 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”.²⁴ 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. More information on the issues with this research can be found in Muir (2014).²⁵

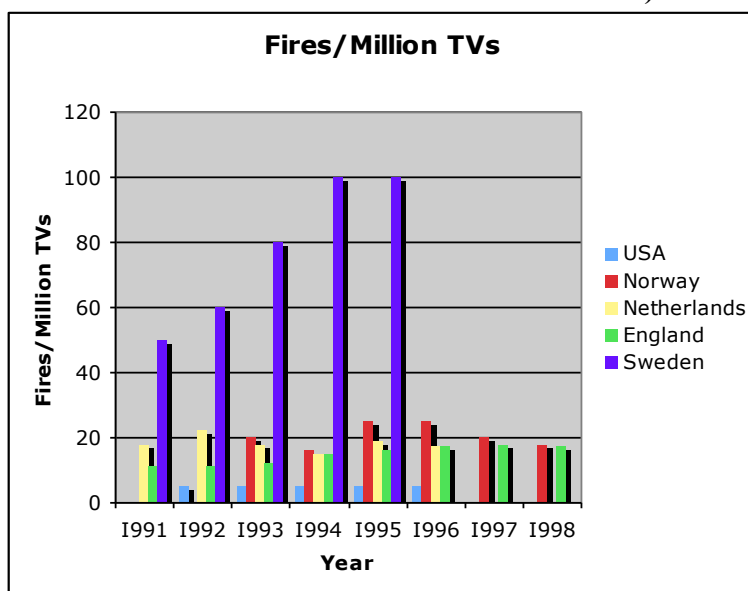
The Consumer Electronics Association (CEA) reported that only five injuries involving the ignition by candles of appliances, only one of them serious had been reported to the US Consumer Product Safety Commission over 11 years on a hotline set up for consumer product-related fire and burn injuries. Based 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.”²⁶

According to a Telecommunications Industry Association (TIA) 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.”²⁷ 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.”²⁸

It should be noted that four sources—CPSC (2000), Hall (2000 and 2002), CEA, and 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 is not peer reviewed, does not provide sources, and is out of line with other published and peer reviewed data.

Figure 2. TV Fires/ million TVs, demonstrating that 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 for Sweden and the Netherlands are from Poortere).



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.²⁹

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.

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.

Section III: Adverse Impacts of Implementing 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.³⁰

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 IEC 62441/Ed1 and any 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,³¹ 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.³²

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 flame 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 flame retardants.

Since all non-BFR plastics would be shredded together, the resulting regrind from mixed flame retarded plastics could have unpredictable and undesirable qualities,³³ 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.³⁴

Although mechanical recycling is increasing, only about 16% of plastics are mechanically recycled today in Europe,³⁵ 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 mechanically 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.³⁶

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.^{37,38} 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.^{39,40}

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.⁴¹

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)⁴² of flame 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.⁴³

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.

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.^{44,45,46,47} In humans, pentaBDE exposure is associated with thyroid hormone changes,⁴⁸ lowered IQ⁴⁹ and neurological impairments.⁵⁰ In addition, the breakdown products and/or metabolites of these chemicals exhibit some of the same toxic effects.⁵¹ According to an American Public Health Association Consensus Resolution,⁵² virtually all organochlorides that have been studied exhibit one or more serious toxic effects, including endocrine dysfunction, developmental impairment, birth defects, reproductive dysfunction, immunosuppressant effects, and cancer, often at extremely low doses.

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,^{53,54} predatory bird eggs,^{55,56} and human serum,⁵⁷ and have the potential to cause adverse health and environmental effects. Also, decaBDE does breakdown to lower, more persistent PBDEs.^{Error! Bookmark not defined.} DecaBDE and TBBPA, like most other flame retardant chemicals, continue to be used in consumer products without adequate knowledge of potential health and environmental effects.

In 2003, the EU (in the RoHS directive 2002/95/EC) and California enacted legislation banning 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.⁵⁸ Other studies have found that PBDEs actually change certain brain receptors.⁵⁹ 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.⁶⁰

PBDEs are similar in structure to thyroid hormone, and exposures causes decreased thyroid hormone levels (serum T4) in mice, rats, kestrals, and frogs.^{61,62} Disruption of thyroid hormone balance may well contribute to the neurobehavioral effects and changes in brain functioning observed after PBDE exposures. The U.S. National Toxicology Program (NTP) has found evidence of carcinogenicity of decaBDE in experimental animals.⁶³

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.⁶⁴ As of 2013, decaBDE has been voluntarily phased out for most uses, including all consumer uses, by the three U.S. producers of flame-retardants, as a result of negotiations with the U.S. EPA. In October 2013, decaBDE has been proposed for listing under the Stockholm Convention. Although decaBDE is no longer used in plastic electronic casings, other similar organohalogen flame retardants such as DBDPE have replaced it.⁶⁵

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 has conducted a two-year cancer bioassay in mice and rats.⁶⁶ *In vitro* studies have established that TBBPA is cytotoxic, immunotoxic, and disrupts thyroid hormone homeostasis.⁶⁷ TBBPA is also a potent inhibitor of estradiol sulfotransferase *in vitro*^{68,69} 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.⁷⁰ A decrease in circulating thyroxine has also been shown *in vivo* after TBBPA exposure in a reproduction study in rats.⁷¹ 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 flame 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 lint⁷² as well as in the food supply, especially in meat and fish.⁷³

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.⁷⁴ 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.^{75,76} 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.⁷⁷ Many brominated chemicals are known or suspected endocrine disruptors.^{78,79} 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.”⁸⁰ Of great concern are adverse neurological outcomes to the developing brain of the fetus from maternal exposure to flame retardant chemicals as has been documented in a series of animal experiments.^{81,82,83} 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.⁸⁴

House cats share our indoor environment and have much higher levels of PBDEs in their blood than do humans.⁸⁵ 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.⁸⁶ Noting that pentaBDE is structurally similar to thyroid hormone, researchers have suggested an association of the high levels of PBDEs in cats and hyperthyroidism.⁸⁷

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, during firefighters’ contact with toxic products released during combustion; and during waste disposal of such products.^{88,89}

Unlike for 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.⁹⁰ Dust is also the major source of exposure for young children.⁹¹ Studies suggest that children have greater body burdens than adults.^{92,93} 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.^{94,95,96}

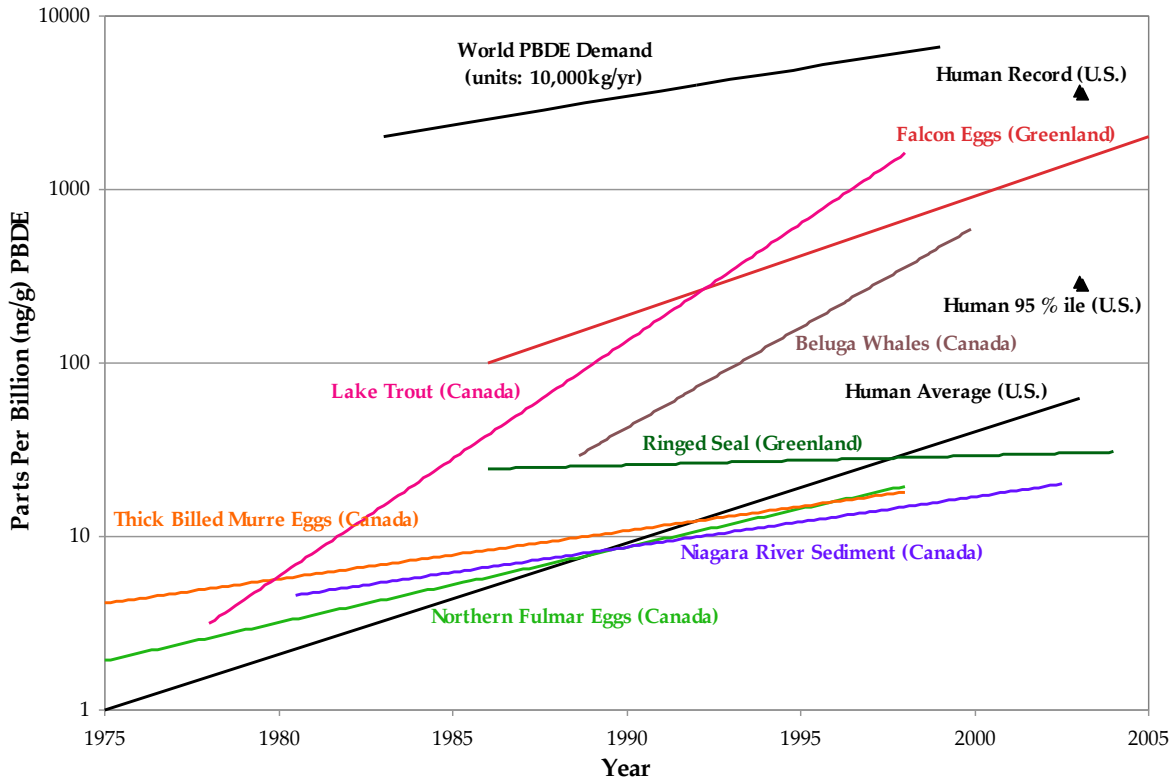
Dozens of scientific studies are under way looking at the relationship of other flame retardant chemicals to birth defects, autism, hyperactivity, reduced fertility and sperm counts and other neurological and reproductive conditions. A study at Copenhagen University Hospital associated cryptorchidism, a condition in which one or both testicles fail to descend into the scrotum, with higher concentrations of PBDEs in breast milk.⁹⁷ In 2006, Swedish research suggested a link between early-onset testicular cancer and higher levels of maternal PBDEs.⁹⁸

The rapid increase in amounts of PBDEs in the environment can be seen from the levels in ten species of wild animals as shown in Figure 3. The increasing body burden of these flame retardant chemicals in wildlife aligns with the increased usage of the chemicals. Though the magnitude of the body burden varies in different animals, the chart below shows the trend is similarly increasing across the eleven studies included in this survey.⁹⁹

The continued failure to adequately evaluate the health and environmental hazards of a series of flame 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 flame retardant chemicals in electronics should be weighed against the health and environmental costs before proceeding to adopt IEC 62441/Ed1, as well as any other similar candle fire retardancy requirements under the IEC or CENELEC.

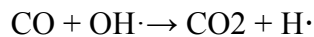
Figure 3. Logarithmic graph of the rapid recent increase in PBDE levels in 10 species of wild animal compared with world demand for PBDEs.¹¹ (Note that the world demand needs to be multiplied by the number on the Y axis.¹⁰⁰)



Effects on Fire Toxicity

Most fire deaths and most fire injuries result from the inhalation carbon monoxide, smoke, soot, and other irritant gases.¹⁰¹ The incorporation of halogenated flame retardants into materials increases the yield of such toxic gases during combustion.^{102,103}

Halogenated flame retardants act by replacing the most reactive hydrogen (H·) and hydroxyl (OH·) free radicals in a flame with more stable chlorine (Cl·) or bromine (Br·) free radicals. The OH· radical, however, is required for the conversion of carbon monoxide to carbon dioxide.



In the presence of brominated or chlorinated flame retardants, this reaction is prevented, resulting in more carbon monoxide (CO).¹⁰⁴ Thus, the same flame retardant action that reduces heat release is also responsible for much higher yields of CO. In addition, the flame-quenching action of Br· and Cl· radicals prevents the oxidation of other like hydrocarbons and aldehydes to carbon dioxide (CO₂) and water, and significantly increases the smoke yield. Increased CO, incapacitating irritants, and smoke hinder an escape from the fire.

Fire effluents from the combustion of materials containing halogenated flame retardants will be more toxic for three reasons:

1. The effluents will contain more carbon monoxide.
2. The effluents will contain powerful irritant acid gases (hydrogen chloride or hydrogen bromide).
3. The effluents will contain a cocktail of respiratory irritants comprising unburned and partially burned hydrocarbons, resulting from stopping the burning process midway.

In addition, as discussed, combustion of organo-halogen compounds leads to the formation of brominated and chlorinated dioxins and furans.

When flame retardants are present, the reduced risk from increased time to ignition and reduced heat release rate during a fire should be balanced against the increased hazard from CO, irritant gases, and particulates like soot or smoke particles.

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 flame retardant chemicals into consumer electronics, as well as substantial profits for the flame retardant chemical manufacturers. Most of the impetus for such open flame standards in consumer products had come from the flame retardant producers, their lobbyist Peter Sparber, the NASFM, and other individuals and organizations associated with the flame retardant industry or Sparber.^{105,106,107,108}

According to an article in the Washington Post,¹⁰⁹ “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.”

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.¹¹⁰ Their industry stands to benefit greatly if a candle requirement is implemented for consumer electronics. 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 flame retardant chemicals in consumer products.

Studies from individuals associated with Peter Sparber, the NASFM, and the flame retardant chemical industry provide much of the original justification for TS 62441 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.¹¹¹ Margaret Simonson has been chair of the Science Advisory Committee of the NASFM. Along with Karen Suhr, who continues to work in Peter Sparber's Washington, DC lobbying firm and also worked with him at the Tobacco Institute, Simonson has been the contact person for the International Consortium for Fire Safety, Health and the Environment (ICFSHE).¹¹²

Including representation from the flame retardant chemical industry in the decision-making process for IEC 62441/Ed1 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.¹¹³

Consumer product companies report that NASFM uses aggressive tactics to encourage their use of flame-retardant chemicals.¹¹⁴ Tactics such as these can push companies into adding flame 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

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.

Adopting the requirement that electronic housings be resistant to a three-minute exposure to a candle flame defined in the IEC 62441/Ed1 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.

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 flame 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.

Sprinkler systems stop nearly all fires without imperiling human health 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.

Sales of the flame 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.

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

Whether the flame 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 flame 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.

We therefore ask the TC108 committees to vote NO on IEC/CENELEC 62441/Ed1.

Appendices

Appendix I: Rebuttals to flame retardant chemical industry statements (in italics) with regard to recycling in “The Case against Candle Resistant Electronics”

“The paper gives reference to the recyclability of flame retarded plastics. In fact, several studies have shown that it is feasible to recycle plastics containing flame retardants.”

Although it is possible to recycle flame retarded plastics, the presence of flame retarding chemicals can be problematic for several reasons, including that the flame retardants can reduce the mechanical properties of the materials, requiring additional treatments and additives to compensate for unpredictable or degraded properties.¹¹⁵ This problem is more pronounced with phosphorus-based additives.¹¹⁶ Unpredictable properties of recycled materials reduce the value of the materials in the market, and reduce the economic viability of recycling.

“The variety of different plastics and the use of a number of different additives is more problematic to the recycling and the economics of recycling [than the use of a single class of chemicals].”

- We make the identical argument as a reason to not introduce new open flame requirements (p17, number 2). Further fragmenting the market for recycled material by introducing a variety of flame retarding chemicals reduces the financial incentives for recycling.
- Neither increased use of BFRs nor the use of several different additives is desirable with respect to recycling.

“Large E&E OEMs and resin producers are very pleased by the use of plastics flame retarded among others by BFRs as they can easily recycle them to produce new equipment with a high value; this would not be possible with plastics not using BFRs.”

Most large electronics original equipment manufacturers (OEMs) have made commitments to remove BFRs from product housings and other components, so recycled plastics containing BFRs cannot be used to “produce new equipment with a high value” for these companies because of the requirement to have a maximum concentration level of 1000ppm PBDEs/PBBs under RoHS,¹¹⁷ or 900ppm Br under certain “halogen free” requirements, or similar voluntary restrictions.

“Moreover such current practice in Japan saves a lot of energy and eliminates large volumes of electronic waste.”¹¹⁸

The development cited is not related to mechanical recycling of plastics. It is a gasification method that can recover metals. Halogenated compounds must still be neutralized. In addition, it is quite new and can hardly be considered “current practice” in Japan.

“Projects conducted by academic institutes show that recycling operations made under severe and extreme conditions as well as incineration tests made with plastics containing BFRs do not produce noticeable toxic smoke. On the contrary the academic studies indicate very significant reduction of the toxicity of smoke once FRs in general and BFRs in particular are used when compared with the much more toxic smoke produced by the equivalent non FR plastic, or beech wood used as a reference.”

Brominated dioxins and furans (PBDD/Fs) can be formed according to chemical routes similar to their chlorinated PCDD/F analogues in thermal treatment of BFR containing polymers.^{119 120 121 122 123} The immediate human health effect of acute toxicity from a combustion event may be different from the toxicity associated with a chemical’s environmental fate, which has been shown to be problematic, especially for BFR containing polymers.^{124 125}

Finally, it should be noted that although the chemical industry and their associates refer to **“The Case against Candle Resistant Electronics,”** as the Greenpeace paper, Greenpeace neither contributed to nor signed on to that paper.

Appendix II: Rebuttal to Blais and Carpenter (2014)

A recent Fire Technology paper¹²⁶ by M. Blais and K. Carpenter, both from the Southwest Research Institute in Texas, US, makes the case for external ignition requirements for TVs. However, this research is severely flawed, as explained below:

1. The authors use the concepts of internal and external ignition interchangeably. For instance, they talk about “the proponents of the health hazard claims(...) pushing for the removal of the external ignition requirements”, but question the wisdom of this by giving examples of internal ignition accidents. If there are electrical faults inside TV circuit boards, the standards should require more rigorous testing of internal circuits, not adding harmful chemicals to TV enclosures.
2. Fire safety action needs to be based on accrued benefits. However, unbiased comparisons of US versus UK fire data indicate a lack of benefits from adding flame retardants to TV enclosures.
3. There are no reasonable scenarios that will ignite flat-panel TV cases from the outside, apart from an ongoing room fire, and in such case, the hazard is governed by the room fire, and not the TV.
4. The authors assume without providing any evidence that ignition by a candle flame is a relevant risk factor for TVs. The statement “Numerous fires have started by placing

ignition sources such as candles or heaters next to readily ignitable items made of plastics” is not supported by evidence.

5. The faster flashover of the modern room is irrelevant to the authors’ arguments. Flame retardants in the plastic casings of TVs are claimed to protect only against small open flames, not against larger flames in the case when the TVs are not the first item ignited.

6. The testing scenarios do not represent “realistic fire conditions”. 50 W is achievable from a faulty component or connection inside a TV set (and from a candle?), but 500 W is out of the range of any electrical fire failure within the unit. (how about for flashover?)

7. The authors talk about “gases of concern”, however they did not report HBr, HCl and HCN, which are toxic combustion products of organohalogen flame retardants.

8. The article downplays the health risks associated with the increased production of BDDs and BDFs from TV cases containing BFRs.

9. The heat released by the non-FR TVs (max 300 kW as reported in this study) is not a significant hazard, as it is considerably less than needed to cause room flashover.

10. There is absolutely no basis to conclude that FRs in TVs do or can save any lives from fire. However, the health risks associated with exposure to flame retardants and their combustion byproducts are well documented, yet not considered in this paper.

11. The article lacks a conflict of interest statement, even though their funding source meets the criteria for a financial conflict of interest.

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Pacific Environment-China
Parents for a Safer Environment

Planning and Conservation League
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Endnotes

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² Approximately 1/3 of electronic housings are currently treated with flame 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.

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