

Health issues with flame retarding chemicals in computers and consumer electronics

This is an excerpt of a series of articles in the danish *Engineering Weekly* about the health problems associated with the use of flame retardants in computers and consumer electronics. The heat from the electronics cause the flame retardants to gass off, and get absorbed into the tissues of the humans who breathe it in. There is concern that these chemicals have the same health effects as PCB's, to which they are much similar.

Environmental Threat from Computer Screens

Flame retarding chemicals in electronic equipment are absorbed into the human bloodstream. Scientists concerned by compounds' close relation to PCB.

(Front page article from "Ingeniøren" ("Engineering Weekly,") the weekly news magazine for members of the Society of Danish Engineers, July 11, 1997. This is an unofficial translation from the original Danish text.)

by Lotte Jorgensen (staff journalist)

TV receivers, computer screens and other warm consumer electronics with cabinets and circuit boards made of plastic emit chemical compounds to the air, which appears to be absorbed into the human bloodstream. The chemicals are the flame retardants, which are similar to another group of chemicals, the PCB's. PCB is currently being investigated for affecting the development of fetuses.

This information comes from a not-yet published study from the Institute of Environmental Chemistry at the University of Stockholm, Sweden. It reveals that the flame retardants emit gasses at just 30-40 degrees Celsius (86 F - 104 F), which is a common temperature inside a PC or TV that is turned on. Until now, it has been assumed that flame-retardants did not create significant emissions.

Increasing usage

The flame retardants consist mostly of polybromine diphenyl ether (PBDE), and tetrabromobisphenol-A (TBBPA). Both compounds are in the study found in blood tests from forty people, which causes concerns, as the compounds see increasing use across the globe.

"It is surprising to find TBBPA and PBDE in human blood tests, and we have reason to believe our concerns about the effects are correct," says Dr. Abraham Brouwer, MD and toxicologist at the Wageningen Agricultural University in Holland, who studies the effect of the two substances on animals and humans.

Fear of Danger to Fetuses

PBDE are chemically close to PCB. PCB is under serious investigation for hormonal effects, which means it can disrupt the development of human and animal fetuses. The researchers think the bromine flame retardants can have a similar effect.

"Of that reason alone, it is incredible that the authorities have not stepped in," says the leader of the Swedish study, professor in Environmental Medicine, Ake Bergman.

The two chemicals are used on printed circuit boards and in plastic cabinets for electronic equipment, where they prevent fires. Those two uses account for about sixty percent of the world consumption of bromine flame retardants, which is estimated at 150,000 tons a year.

The Danish producer of consumer electronics, Bang & Olufsen (B&O), have already stopped the use of PBDE-treated circuit-boards in their TV-sets, due to these concerns. Instead, they use TBBPA, which will not be substituted in the near future, says Engineer and Technical Consultant Rikke Nedemark, B&O.

The article in the same issue of *Ingeniøren* elaborated further on the problem, showing the similarities between Tetrabromobisphenol A (TBBPA), Polybromine diphenyl ether (PBDE) and Polychlorinated biphenyl (PCB). Flame retardants are mentioned as being widely used in photo-copy machines, fax machines, telephones, radios, kitchen appliances, furniture and a lot of other places. Some of the side-bars are translated:

Chemical Compounds Accumulate in the Body

The two fire-retardants PBDE and TBBPA are similar to PCB's in their chemical structure. PCB is suspected to be interfering with the development of fetuses and the human brain.

Like PCB, it is assumed that PBDE is easy to accumulate in a food chain, and difficult to break down by the body's enzymes. This means that the body tends to accumulate the chemical, rather than excrete it, says the leader of the study, Ake Bergman, Professor of Environmental Chemistry at the University of Stockholm, Sweden. Much points to an accumulation in the human body, by direct exposure, by breathing it in while working at a computer, where the plastic is heated up and thus emits the more volatile gases.

On the Wageningen University of Agriculture, Holland, Dr. Abraham Brouwer, MD, department of Toxicology, has been investigating TBBPA and PBDE's effect on humans and animals over the last year in the EU-supported research program that is led by Professor Ake Bergman.

By incorporating TBBPA, PBDE and natural hormones into rat-livers, the results show so far that when the compounds are absorbed into the body, they are capable of competing with some of the natural hormones in the body. They attach themselves to the proteins that carry the hormones, outmaneuver the natural hormones and interfere with the natural development of a fetus.

Scientifically, it is now known that these compounds can compete with the natural hormones of the body. Whether the compounds have a PCB-like effect is still only speculation, however. Dr. Brouwer think it is too early to make conclusions on that yet.

- "On the other hand, given what we now know, it is cause for concern, since we know these compounds can influence the hormonal systems, and we need to look into that further."

Revealing Air Tests

It all really began with the end. The recycling business Stena Technoworld in southern Sweden gather discarded electronic appliances from Norway, Denmark and Sweden. First, the cabinets are taken apart and the plastic components sorted after type and additives, such as flame retardants.

When measuring the content of flame retardants in the plastic cabinets, the content was lower than expected. The content is not as high as when it was new. This created suspicion that the chemicals might gas off during the life of the appliance.

To get an overview of the problems in offices with many computers, fax machines, TV's and copiers, a few environments were tested: A computer room with PC's, a sixty sq. foot office with a PC and a printer in the center of Stockholm, a secretary's office of 150 sq. feet, with two PC's and a fax-machine, and one other university office, of the same size, but only with one PC and a printer. Finally, one 70 sq. foot office with a PC at the swedish national institute of environmental health was tested.

Tests of the air was conducted over a week, and tested for chemical compounds. Besides TBBPA and BPDE, the tests showed nine types of organic phosphates and minute amounts of several phtalates. The test focused on whether these compounds where present, not how much was present.

The results indicate new risk areas for people being exposed to environmental hazards.

To protect the workers at Stena Technoworld, the company will now test the indoor climate and the workers for flame retardants.

Follow-up articles in subsequent issues of Ingenoren:

July 25, 1997:

A follow-up article looks at the environmental hazards when electronics are thrown away. If it is burned in an incenerator (as most garbage is in Scandinavia), the chemicals can create dioxins, which are a known cancer-agent. This problem is also present if a TV-set burn in someones home.

August 1, 1997:

Under the heading "While the Red Warning lights are Blinking," the editorial lambasted the Danish EPA (Environmental Protection Agency) for not doing anything about this problem, while some countries, like Sweden, Germany and Holland have taken steps to limit the use of the bromine flame retardants.

August 8, 1997:

The Director of the Danish EPA says that they have taken steps to get more information from the new Swedish study, and will look at the issue with concern.

August 15, 1997:

The magazine brings an interview with Finn Bro-Rasmussen, Professor of Environmental Studies at the Technical University of Denmark. He argues for immediate restrictions on the use of bromine flame retardants, as well as several other flame retardant chemicals. They can create dioxins if they burn, which can cause cancer in humans. He mentions that there are big holes in our knowledge of these and thousands of other chemicals we use daily. Companies designing electronics should think in new directions when protecting their products against fire, instead of simply using flame retardant chemicals as a band-aid.

Another article mentions the many inquiries the magazine have received from Danish industry, including Scandinavian Airlines (SAS), which use flame retardants extensively in their airplanes, including the uniforms for the flight attendants.

September 5, 1997:

The German EPA, Umweltbundesamt, is planning a large-scale investigation of bromine flame retardants, which will form the basis of a regulation of the area. The Germans have lost patience with the EU ten-year attempt to look into the problem, and will now make their own national regulations, explains Cornelia Elzner from the office of compound-related issues in the Umweltbundesamt. Last year, the agency collaborated with the German car industry in looking into whether flame retardants were needed in the car seats of new cars, it was not.

The agency will also look into what compounds can be used as substitutes, where flame retardants are still needed.

Another article mentions that the Peoples Socialist Party in Denmark has asked the Minister of the Environment to get the Danish EPA to look more closely into this issue, with specific goals on banning the usage.

October 10, 1997:

A short notice says that the Danish EPA now will be asked by the Danish government to look into the health risks of the bromide flame retardants.

Lawsuit against use of flame retardants

by Lotte Jorgensen (staff journalist)

New indications that the flame retardant compound PBDE is just as poisonous as PCB. A 28-year old Israeli demands \$5.5 million from the TV-manufacturer Sharp.

The Engineering Weekly (Ingenioeren), Friday February 13th, 1998.

The 28-year old Israeli Elad Shetreet has demanded about \$5.5 million from the Japanese TV-manufacturer Sharp Corporation. He believes he has been poisoned by bromide diphenyl (PBDE) from a Sharp television set.

Multiple experts have examined blood and tissue samples from the man and samples from the TV set, and they support his opinion that there is a possible connection. If he wins the case, it will be the first time ever that flame retardants have been accepted as having the same health-effects as the known poison PCB (polychloride biphenyl).

At the same time, it will confirm the conclusions of a Swedish report, that last summer revealed bromide flame retardants can migrate from electronic equipment over into human blood and tissue (see Engineering Weekly, issues 28 and 29, 1997), with the risk for everybody who are in close proximity to computers, fax machines, photo copiers and TV sets.

Four hours in front of the television, in a closed room

In 1982, Elad Shetreet's parents bought a new TV of the brand Sharp, model 2001G-C, which the then 13-year old Elad used to play computer games on. The games occupied him so much that he the following eight months spent up to four hours a day in front of the screen, which was placed in a small room with no ventilation.

It is these circumstances that today gets Elad Shetreet to blame his later sickness on the flame retardants from the TV, which he says are emitted from the plastic cabinets by the heat from the TV set.

The year after, in 1983, an Israeli doctor diagnosed him with a serious case of acne on the legs and the back, as well as nose bleedings and faintings. In the following year, the problems with his skin got worse and spread. Other health problems arise, such as a discoloration of his hair, which also starts to fall off. He gets trouble with his eyesight and his hands start to shake. In 1996, an ultrasound scan shows an enlarged liver.

Signs of sickness mimics PCB-poisoning

The symptoms create the suspicion that Elad Shetreet has been exposed to some sort of chemical poisoning, since there are similarities to known cases of poisoning with PCB, a compound earlier used in the insulation of electrical equipment.

Elad Shetreet's condition is unusual enough to get the attention of multiple scientists, who offer their assistance for free.

The suspicion about the origin of the disease increases when the laboratory for the French Nuclear Ministry finds chromosome changes in a blood sample from Elad Shetreet, and it is suspected to be caused by chemical exposure. Then the now 21-year old Israeli, who is unable to work, contacts the Netherlands Institute of Fisheries Research, which have studied the effects of PCB's on humans and the environment for several years, and also have looked into the effects of PBDE. Dr. Jacob de Boer from the institute receives a sample of Shetreet's fatty tissues and finds PBDE in it.

The concentrations are small, and since several years have passed since Shetreet was thought to have been exposed to PBDE from the TV-set, it is hard to determine how it has gotten there.

None the less, the compound is in his tissue, and it is not a compound one would normally expect to find in human tissue, so we were very surprised to even see it, explains Dr. Jacob de Boer.

De Boer looks for PBDE in a variety of foods from Shetreet's diet, but without luck, and in 1992 he concludes that the presence of PBDE is highly unusual and exceptional in Shetreet's case.

The TV-set was examined in May of last year, where professor in environmental chemistry, Muefit Bahadir from the University of Braunschweig in Germany, find traces of PBDE on the insides of the cabinet, which indicates that PBDE has been used as a flame retardant and it has somehow been released to the air from a component in the TV set. Professor Bahadir is still looking for the source, but finding PBDE on the inside of the cabinet proves that PBDE has been released to the air and thus may have been able to migrate further.

The final proof of poisoning is still missing

Another expert, Larry Robertson with a ph.d. in toxicology at the University of Kentucky in the United States, enters the case and he provide a report together with Dr. de Boer in Holland which shows the likelihood that Elad Shetreet has become ill due to PBDE from the TV-set.

The case is now so far that Elad Shetreet have proof from both sides: That PBDE exists in both his fatty tissues and in the TV set. But the last piece is missing: The proof that the PBDE from the TV set did enter Elad Shetreet's body, and it did make him sick.

The final evidence may be just around the corner, since another dutchman, Dr. Abraham Brouwer from the Department of Toxicology at the Wageningen Agricultural University now have started the first animal experiments to investigate the effect of bromide flame retardants, such as PBDE.

Dr. Brouwer researches the effect on humans and animals in contact with the two flame retardants, PBDE and TBBA (tetrabromidebisphenol-A). He last year told *Engineering Weekly* how the first lab tests showed that when the compounds are absorbed into the body, they are able to compete with certain of the natural hormones in the body. By binding themselves to the proteins that carry the hormones, the compounds outstrip the natural hormones and thus disrupts the development of a fetus.

This is close to how PCB behaves, and the chemical structure of PBDE does look like PCB's. However, it is first when the results of the animal tests are completed that Dr. Brouwer will make a statement whether PBDE has the same harmful effects as PCB.

Like Dr. Brouwer and his Swedish colleague, Dr. Ake Bergman, Dr. de Boer returns to the original thought: That bromide flame retardants, such as PBDE, are very similar to PCB in their molecular structure.

"I think everyone in the scientific community is convinced that PBB and PBDE is very similar to PCB. I think it's unbelievable that governments have not taken any precautions against these compounds, since they are so much like PCB, and thus one can expect the same harmful effects as from PCB."

While the scientific experts keep looking for the final proof, Elad Shetreet's lawyer in Israel only need to show the probable link between the PBDE in the TV set and the illness of his client to win the lawsuit against the Japanese company. So far, Sharp has requested to have the court case moved to Japan. Timing can be an important factor, and in the long run depend on Dr. Brouwer's results.

PCB-posioning

The toxicity of PCB is especially known from two cases of PCB-pollution. One case is the pollution of large parts of Lake Michigan for many years by the Monsanto factory, which made many people sick. In the other case, five Japanese died in 1968 after ingesting food containing cooking oil polluted with PCB.

The common symptom for the PCB-victims are serious cases of acne, especially in the face and on the back, deformed and miscolored nails and hair, and often loss of hair.

The victims also get digestive problems and loose weight. Inner organs can also be damaged, such as an enlarged liver and changes in cell structures. In some cases people have died from heart problems.

The Engineering Weekly, Friday November 12, 1998.
Letter to the editor:

Denmark should learn from Sweden

Sidsel Dyekjaer, The Ecological Council

In the last few years, more and more alarming research reports have appeared regarding the dangers of the bromide flame retardants. In Sweden, the authorities have reacted by announcing bans and work with the industry, while we in Denmark have been more hesitant. We are reluctant to be ahead of the European Union (EU). In Sweden, the hope is to lead the way for the rest of the EU.

Bromide flame retardants include hundreds of chemicals dangerous to the environment, which are used in large amounts in electronic equipment. Especially three product groups are being focused on: PBDE, PBB and TBBPA. A number of new reports, as earlier mentioned in this journal, have shown the presence of PBDE and TBBPA in human blood, increasing amounts in mothers' milk, brain damage in newborn mice, caused by PBDE, and hormonal effects in rats. The compounds are also thought to be connected with spontaneous abortions and changes to the immune system. The compounds are persistent, so they become widely dispersed in the environment. They have been found in fish, seals and whales.

A suggestion to bring down the use of bromide flame retardants was included in the Swedish governments proposed environmental goals for 1998. The Swedish Chemical Inspection (Svenske Kemikalieinspektion) have now been asked to look at the possibility of a ban of PBDE and PBB. It is discussed to ban them from January 1st, 2004. This would go along with the EU directive about electronic garbage, and will give the industry five years to develop alternatives.

The Danish EPA has started a project to determine the usage and the possibilities of a substitution. Bromide flame retardants are also included on the Danish EPA's "list of undesirable compounds," but there is no real public debate about it in this country, and the politicians have not done anything to bring down the usage. They just await the EU risk assessment. This probably means that it will take a number of years before anything happens, since projects within the EU usually take a long time. The EU discussions about PBDE have so far lasted ten years.

Sweden has for a long time had a public debate about bromide flame retardants. That has resulted in some Swedish importers already now requiring goods without PBB or PBDE. The industry has also been asked to report the presence of PBDE and PBB in electronic goods and components before January 1st 2003, and also perform a risk assessment for TBBPA before January 1st 2001.

The Swedish Chemical Inspection and the Swedish IT-industry organization (SITO) have made an agreement, which includes the goal of eventually stopping the use of PBB and PBDE. The agreement is in two steps: Bromide flame retardants must be out of all components weighing more than 25 grams (0.8 oz) before year 2000, and in all components before year 2005. It is done in steps, as there are still problems finding alternative flame retardants for the small printed circuit boards, while there are already good alternatives for larger plastic components.

There are already PCs on the market, also in Denmark, which are without bromide flame retardants in the larger plastic components. This decreases the total amount of flame retarding chemicals substantially. A number of countries, including Sweden and Germany, are working on developing alternatives to bromide flame retardants for printed circuit boards. This work is especially inspired by the demands from politicians and consumers.

It is high time that the Danish market and Danish politicians also start to require electronic products without bromide flame retardants.

Contact information:

Report on the Results from a pilot project on additives to plastic in electronic goods Ake Bergman, Institut for Miljokemi, University of Stockholm, 1997.

Researchers mentioned in article:

Dr. Åke Bergman, University of Stockholm (Ake.Bergman@mk.su.se)

Dr. Jacob de Boer, Netherlands Institute of Fisheries Research

Dr. Finn Bro-Rasmussen, Technical University of Denmark

Dr. Abraham Brouwer, Wageningen Agricultural University

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