

# Toxicity of Chemicals Contained in Everyday Electronic Devices: A European Perspective

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## I. INTRODUCTION

**W**HY toxicity in everyday electronics matters ? Most of our electronic devices contains chemicals. Some are inoffensive and other can be harmful. Harmful chemicals are widely used and sometimes for security concern. In Europe, we have a policy to regulate the amount of the toxic known chemicals. Despite this regulation, we are still exposed to these chemicals. This review will focus on the toxicity of chemicals contained in everyday electronic devices from a European perspective. The purpose of this work is to give an overview of the most common toxic chemicals in electronic devices and how they can affect humans.

## II. TOXIC SUBSTANCES IN EVERYDAY ELECTRONICS

Electronic devices can be toxic in multiple ways and we use them everyday. This state of the art report will only treat about the toxicity of the chemicals contained in the devices. It is important to know that not only the electronic components themselves contain toxic compounds but also the metal or plastic casing, the wiring, the solder and other mechanical or electrical items that could be included in most of the electronic devices.

The most common and well-known toxic chemicals are listed in Table I. Brominated Flame Retardants (BFR) are a big concern since they are used in most of electronic device for safety policies imposed by EU [1]. The BFRs are extremely present in our lives and are able to bioaccumulate. They are dangerous for most of the living beings as they are endocrine disruptors and carcinogenic [2], [3]. They are present in pcb and incorporated in polymers which are used for casing. This means we are almost constantly in contact with BFRs. The two most common BFRs are Polybrominated Biphenyls (PBB) and Polybrominated Diphenyl Ethers (PBDE).

Another important heavy metal is Lead (Pb). It was widely used in old solders and is still present in some batteries and electronic components. Lead is extremely toxic for humans and can lead to neurological disorders, especially for children [4], reproductive system, immune system, nervous system and kidneys disorders [5], [6]. It is also restricted by the EU regulations [7].

Phthalates are also widely used in electronic devices as plasticizers. They are used to increase the flexibility of plastics and cables. —¿ TO DEVELOP

TABLE I  
TOXIC CHEMICALS IN ELECTRONICS — EU LIMITS

Substance	Max %	Common uses
Lead	0.1	Solders, cable sheathing, CRT-glass
Mercury	0.1	Switches, sensors, lamps
Cadmium	0.01	Ni-Cd batteries, electroplating
Cr VI	0.1	Coatings, metal plating
PBB	0.1	PCBs, plastic housings
PBDE	0.1	PCBs, cable insulation
DEHP	0.1	Cable plasticizers
BBP/DBP/DIBP	0.1	Plastic components

Note: PBB = Polybrominated Biphenyls; PBDE = Polybrominated Diphenyl Ethers; DEHP = Di(2-ethylhexyl) phthalate; BBP = Benzyl butyl phthalate; DBP = Dibutyl phthalate; DIBP = Diisobutyl phthalate; Cr VI = Hexavalent chromium. Maximum concentration limits are based on EU RoHS Directive [7].

Cadmium (Cd) is another heavy metal used in batteries (Ni-Cd), electroplating and coatings. —¿ TO DEVELOP

Mercury (Hg) is used in some switches, sensors and lamps. —¿ TO DEVELOP

Hexavalent chromium (Cr VI) is used for corrosion-resistant coatings and metal plating. —¿ TO DEVELOP

Other toxic chemicals can be found in electronic devices but are less common. —¿ TO DEVELOP

## III. EXPOSURE PATHWAYS

How are we exposed to these toxic chemicals ? The main exposure pathways are inhalation, ingestion and dermal contact. —¿ TO DEVELOP

## IV. EU REGULATORY FRAMEWORK

What does EU impose regarding these toxic chemicals ? Are the regulations sufficient to protect us from these toxic chemicals ? Are the regulations well enforced ? —¿ TO DEVELOP

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