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The thought of waking up on Christmas morning to find gifts under the sparkling Christmas tree brings joy to one's heart. This elation would completely change to fear if those gifts were stamped with black skull and crossbones indicating that they contain poison, such as PAH chemicals. But truly, how are we to know what chemicals are in the materials used to fabricate our toys and electronic gifts that we will be giving to our loved ones?

Recently [PAH chemicals](#) have been found in consumer products, such as toys, sporting goods, tools, shoes, and electronics. According to the German Federal Institute for Risk Assessment (BFR), "Products for everyday use by consumers and children sometimes displayed very high PAH contents". Typically, these PAH chemicals are not added intentionally but they are present as impurities in some of the raw materials that are used in the production of the consumer products.

[Polycyclic Aromatic Hydrocarbons \(PAHs\)](#) are hazardous for both our human health and the environment. Many PAHs have been found to be toxic, mutagenic and/or carcinogenic. PAHs are found naturally in the environment and they have been around since the origin of the galaxy. Whether by nature or by man, PAH's are typically created as environmental pollutants from the incomplete combustion of organic materials. In the late 16<sup>th</sup> century Percivall Pott, a surgeon in London, noted that cancer was unusually common in chimney sweepers and proposed the cause as occupational exposure to soot.

Being a chimney sweep was not a fun and exciting occupation as it is portrayed in the Mary Poppins movie. In fact they were typically orphan boys who would climb inside to clean the flues in "the buff", rarely bathe, then they slept on their masters floor under bags of soot to keep them warm. A nasty job at the lowest level of society and most assuredly not "Chim

Chiminy, Chim Chiminy, Chim Chim Chiree, when you're with a 'sweep, you're in glad company." Now today we know that many of the hazardous chemicals in soot, and coal tar, are in fact PAH chemical compounds.



PAHs are not easily dissolved in water and they are lipophilic which means they are readily absorbed and distributed in an organism's fatty tissues. In general, the more aromatic rings in the PAH molecule, then the better it accumulates in the body, and in addition PAH can bind to cellular proteins and DNA. It is shown in tests on animals that they can lead to mutations, create both immunosuppressants and birth defects, and in many cases cause cancer. Even worse are the potential nitrogen derivatives of PAH (NPAH), which are even more carcinogenic and mutagenic. In response to these concerns, the European Union has classified many PAHs as carcinogenic, mutagenic, and reprotoxic (CMR).

There are eight PAHs that are included in the REACH Annex XVII restricted substances list. These PAHs are restricted from use in rubber extender oils and articles supplied to the general public, especially to children. The EU Commission Regulation Number 1272/2013,

that amends this regulation, lists eight PAH components as classified carcinogenic category 1B:

1. Benzo[a]pyrene
2. Benzo[e]pyrene
3. Benz[a]anthracene
4. Chrysene
5. Benzo[b]fluoranthene
6. Benzo[j]fluoranthene
7. Benzo[k]fluoranthene
8. Dibenz[a,h]anthracene

The EU restricts the sale to the general public of commercial articles if they contain more than 1 mg/kg (0.0001 % by weight) of any of the listed PAHs, if any of their components come into direct as well as prolonged or short term repetitive contact with the human skin or the oral cavity while under normal or reasonably foreseeable conditions of use. In addition, the [Product Safety Commission \(AfPS\)](#) in Germany has assigned the requirements of PAH testing in the course of GS mark certification as a specification according to article 21 Product Safety Act (ProdSG) paragraph 1 number 3. There are 18 different PAH chemicals on this list (Table 1) which are not to exceed the individual limits of 0.2 to 1 mg/kg (depending on the contact category).

The [International Electrotechnical Commission \(IEC\)](#) is the world's leading organization that prepares and publishes International Standards for all electrical, electronic, and related technologies. The widespread use of electronic products has drawn increased attention to their impact on the environment. Due to the concern on their environmental impact and the associated effects on our health, the IEC created test series 62321 as an international standard to determine the levels of the concerned substances for daily use. Part 10 in this series is a test for measuring PAHs in polymers and electronics by gas chromatography-mass spectrometry (GC-MS). According to the IEC test method, considering the vulnerability of children, a lower limit value should be established. Therefore, the placing on the market of toys and childcare articles, containing any of the PAHs in concentrations greater than 0.5 mg/kg in their accessible plastic or rubber parts, should be prohibited.

For the development of the analytical method, the IEC used a standard solution that is a mix of several suspect PAH chemicals which are the same as those listed in AfPS GS 2014:01 (shown in Table 1). The following parameters are recommended in the IEC report:

Table 1. List of PAH components restricted in AfPS GS 2014:01

Parameter	Category 1	Category 2		Category 3	
		Toys in the scope of 2009/48/EC	Other products in the scope of ProdSG	Toys in the scope of 2009/48/EC	Other products in the scope of ProdSG
Benzo[a]pyrene, mg/kg	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Benzo[e]pyrene, mg/kg	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Benz[a]anthracene, mg/kg	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Benzo[b]fluoranthene, mg/kg	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Benzo[j]fluoranthene, mg/kg	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Benzo[k]fluoranthene, mg/kg	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Chrysene, mg/kg	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Dibenz[a,h]anthracene, mg/kg	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Benzo[g,h,i]perylene, mg/kg	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Indeno[1,2,3-cd]pyrene, mg/kg	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Acenaphthylene, acenaphthene, fluorene, phenanthrene, pyrene, anthracene, fluoranthene, mg/kg	<1 (sum)	<5 (sum)	<10 (sum)	<20 (sum)	<50 (sum)
Naphthalene, mg/kg	< 1	< 2		< 10	
Sum of 18 PAHs, mg/kg	< 1	< 5	< 10	< 20	< 50
Category 1	Materials intended to be put in the mouth, or materials of toys with intended to long-term skin contact (longer than 30 seconds)				
Category 2	Materials not covered by Category 1, with foreseeable skin contact for longer than 30 seconds (long-term skin contact) or repeated short-term skin contact				
Category 3	Materials not covered by category 1 or 2 with foreseeable skin contact up to 30 seconds (short-term skin contact)				

Typical chromatography analysis run times are 45 to 60 minutes when using test method IEC 62321-10 Ed.1.0 and the established AfPS GS 2014:01 test procedures. For this application Phenomenex has developed a proprietary selectivity to analyze and resolve critical PAH components per the IEC test method. The [Phenomenex Zebron™ ZB-PAH GC column](#) not only resolves critical PAH components but it reduces the analysis run time from 45 minutes down to 27. Protecting our environment is of course important, and Phenomenex is diligent in working with our regulatory agencies to ensure the protection of consumers safety, so that we can provide gifts that are going to harmlessly bring cheer to our loved one's hearts. For further details on Zebron™ ZB-PAH and its joyful separation performance please see the technical note on our web site: [Polycyclic Aromatic Hydrocarbons \(PAH\) in Electronic Components using Zebron™ ZB-PAH by GC-MS](#)

From the Phenomenex family have a glorious and safe holiday!

“The best of all gifts around any Christmas tree: the presence of a happy family all wrapped up in each other” – William E. Vaughan

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