

Potential category: “aryl (or phenyl) organophosphate esters”

While researching flame retardants for the MA Flame Retardants (FR) Law of 2020, a group of non-halogenated phosphate esters, specifically aryl organophosphate esters and derivatives, came into focus as an important potential chemical category for listing under TURA due to human and environmental hazard characteristics. None of these chemicals are currently covered by the MA FR Law or MA TURA. In addition to their use as flame retardants, chemicals in this category are also used as plasticizers and lubricants in hydraulic fluids, rubber, paints, textile coatings, food packaging, and PVC.

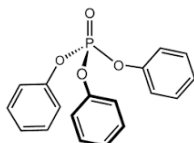
This chemical category first came to TURI’s attention through a research article by Lola Bajard et al, [“Prioritization of hazards of novel flame retardants using the mechanistic toxicology information from ToxCast and Adverse Outcome Pathways,”](#) Environmental Sciences Europe, 2019, 31:14. Of the 62 flame retardants studied, 23 were given a Category I¹ or Category II² designation. Of those 23, 6 are aryl organophosphate esters. (Among the others, 5 have already been discussed as part of the MA FR Law.)

In the March 2023 ECHA report, [“Regulatory Strategy for Flame Retardants,”](#) the ‘triphenyl phosphate derivatives’ category was identified with 18 members and the statements:

- triphenyl phosphates are all potential reproductive toxicants with a potential for ED hazard for human health and the environment
- polyphosphate derivatives (of the triphenyl phosphates) are inconclusive with regard to reproductive toxicity, ED and neurotoxicity and require further clarification

While researching two flame retardants included in the MA FR Law TURI found recent research by [Witchey](#) and [Rock](#) on the flame retardant Firemaster 550, a mixture of tetrabromophthalate, tetrabromobenzoate and aryl phosphate esters, found that the aryl phosphates in the mixture were responsible for the neurotoxic effects seen.

In order to continue with this research, TURI identified names and CAS numbers for approximately 30 members of this category and began collecting toxicological data. All category members are derivatives of triphenyl phosphate with the basic structure:

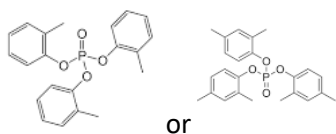


With this as a base, four groups emerge:

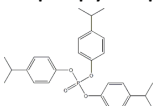
¹ Category I: Substantial toxicological data indicating toxicological concern.

² Category II: Scarce toxicological data indicating toxicological concern. There were 5 categories in total, III-substantial toxicological data indicating lower toxicological concern; IV-scarce toxicological data indicating lower toxicological concern; V-insufficient toxicological data to evaluate the toxicological concern

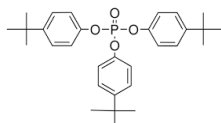
- Tricresyl and trixylenyl phosphate and derivatives – addition of methyl groups, such as



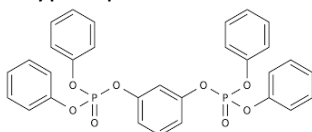
- Isopropyl triphenyl phosphate and derivative – addition of isopropyl groups, such as



- Butyl phenyl phosphate and derivatives – addition of butyl groups, such as



- Polyphosphate derivatives – two phosphate groups, such as



At least three members of this category are data-rich: triphenyl phosphate, tricresyl phosphate, isopropyl triphenyl phosphate.

Examples of the health effects reported are:

Triphenyl phosphate	Neurotoxicity, cardiotoxicity, decreased sperm concentration, cytotoxicity, affects cognitive or behavioral development	The Toxicity of Environmental Pollutants
Tricresyl phosphate	Neurotoxicity	In vitro neurotoxic hazard characterization of different tricresyl phosphate (TCP) isomers and mixtures
Isopropyl triphenyl phosphate	Aquatic tox, potential for reproductive and developmental effects, neurological effects and effects on systemic organs, specifically adrenals, liver, ovary, and heart in mammals	Phenol, Isopropylated Phosphate (3:1) (PIP 3:1): Regulation of Persistent, Bioaccumulative, and Toxic Chemicals Under TSCA Section 6(h)

At this initial stage, TURI is asking the SAB to offer thoughts about this potential category.