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I, David Epel, am writing this statement in support of the Petition to the CPSC to regulate four categories of household products containing non-polymeric additive organohalogen flame retardants.

1. I, David Epel, am a Jane and Marshall Steel Jr. Professor Emeritus of Biological and Marine Sciences at the Hopkins Marine Station of Stanford University. I have a Ph.D. from the University of California, Berkeley. I have been a Guggenheim Fellow, and am a Fellow of the American Association for the Advancement of Science, a Fellow of the California Academy of Sciences, and a Life Fellow of Clare Hall of the University of Cambridge in the UK. I was awarded the Ed Ricketts Memorial Award for Lifetime Achievement in the Marine Sciences. Please see my CV and list of publications accompanying this statement.

2. One of my areas of research deals with the cellular and molecular mechanisms that allow embryos to resist the effects of environmental stresses such as ultraviolet radiation, pathogens and natural and man-made toxins. My expert opinion below is based on my work on the primary line of defense against toxic substances provided by a large family of efflux transporters known as ABC (**A**TP-**b**inding **c**assette) transporters.

3. These ABC transporters are proteins in the plasma membrane of cells that act as “bouncers” to keep toxic substances out of cells, and also as “garbage collectors”, removing chemicals that evaded the original bouncer action. All organisms, from bacteria to plants to humans, employ this defense system. If the transporters can recognize a chemical, they can then prevent its entry into the cell. A well-studied example of this mechanism is resistance to cancer chemotherapy, which can develop during the course of cancer treatment. When cells are exposed to anti-cancer drugs, they often respond by elevating the number of ABC transporters. This keeps the anti-cancer drugs out of the cell and makes the cells resistant to chemotherapy.

4. Some chemicals seem to evade this bouncer defense, for example teratogen thalidomide, neurochemical methyl mercury, and organohalogen compounds such as DDT, PCBs and chlordane. These chemicals are not recognized by the ABC transporters. The cell also has little capacity to metabolize or convert these chemicals to less toxic forms. As a result, these chemicals accumulate in the cell, where they remain for the lifetime of the cell – a legacy of prior exposure.

5. A large group of organohalogen flame-retardants are similar to DDT, PCBs and chlordane in that they have very low water solubility and have carbon-halogen bonds. These chemicals:
(1) Are not transported out of the cell by the ABC transporters.
(2) Are fat soluble, so they can permeate the cell membrane and enter the cell.

(3) Are not metabolized by the cell or converted to forms that can be eliminated.
Consequently, the organohalogen flame-retardants with low water solubility persist in many organisms including in humans, fish, and marine mammals.

6. A colleague has recently studied the interactions between some PBDE congeners (which are also organohalogen flame retardants with very low water solubility) and the ABC transporters. He found that the studied PBDEs inhibited the ABC transporters, which could explain the inability to transport these chemicals out of the cell. This inhibition would also impair the cell's defenses, altering its ability to keep other toxic compounds out. My colleague is continuing to study other organohalogen flame retardants, but these preliminary results are of concern, as they suggest that organohalogen flame-retardants can not only cause biological harm on their own, but also potentially exacerbate the harmful effects of other chemicals.

7. All organohalogen flame-retardants form a structurally similar chemical class, characterized by one or more halogens (chlorine or bromine) bound to carbon. Those that have very low water solubility can bioaccumulate and have the potential to produce the adverse biological effects described above, as my research on their interactions with the ABC transporters has shown. The more water-soluble organohalogen flame retardants do not tend to bioaccumulate. However, as a result of their carbon-halogen bonds, they are also not natural to mammalian biochemistry and may not be recognized by the ABC transporters. Animal and epidemiological studies have linked exposure to the more water-soluble organohalogen flame retardants (most of which are organophosphates) to adverse health effects. Thus, sufficient evidence from scientific studies shows a substantial potential of harm from the entire class of organohalogen flame-retardants (i.e. both water-soluble and water-insoluble).

8. To conclude, my research, as well as the research of many other colleagues, has shown that properties shared by all organohalogen flame-retardants as a class can lead to adverse effects for human health. This class of chemicals easily enters the cells, may decrease the cells' ability to keep out other toxic compounds, and can cause adverse health effects. Because of these findings, my professional opinion is that consumer products containing non-polymeric organohalogen flame-retardants in additive form (which results in exposure) should be banned, as explained in the accompanying petition.

Yours sincerely,

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