



Firefighting and Your Health

Exposure to Dioxins and Furans

What are Dioxins and Furans?

Dioxins and furans are a group of closely related chemicals created as byproducts of combustion or industrial processes. Often, this group of chemicals is simply referred to as “dioxin”.

Dioxins and furans are made up of carbon rings formed during incomplete combustion. Either chlorine or bromine atoms are attached to the outside of the rings. The final structure of the dioxin is dependent on the material burned, but both chlorinated and brominated dioxins are long lived, toxic and build up in the body over time.

How are Firefighters Exposed to Dioxins and Furans?

Most dioxins and furans are created during combustion, but some are byproducts of industrial processes such as paper bleaching and pesticide manufacturing. Dioxins and furans appear to be produced by almost all combustion. Even forest fires produce small amounts of dioxins and furans; however, materials with high concentrations of chlorine and bromine produce the highest levels upon combustion. Structural fires are known to be a source of dioxins and furans.ⁱⁱ Firefighters are exposed to dioxins and furans in smoke and soot during calls. For example, firefighters who responded to the World Trade Center disaster were found to have elevated levels of dioxins in their blood and urine.ⁱⁱⁱ

Some materials produce more dioxin than others when they are burned. Polyvinyl

chloride (PVC)-based plastics and materials containing brominated flame retardants produce dioxins when burned. Polyvinyl chloride (PVC) is a plastic used to make pipes, wall coverings, siding, decking, fencing, shower curtains, furnishings, and kitchen floors. When PVC-based materials are burned, they release high concentrations of dioxins and furans.^{iv} In addition, heating and combustion releases benzene, hydrogen chloride and other toxic gases.^v Brominated flame retardants are used to slow the rate of burning in plastics, foams, fabric and other materials. These flame retardants convert into dioxins and furans when burned.^{vi} Materials treated with brominated flame retardants also create more carbon monoxide and smoke, while providing a very little increase in fire resistance.^{vii} These chemicals pose an unnecessary risk to firefighters.

How do Dioxins and Furans Affect Health?

People are exposed to dioxins every day through food, air and water.^{viii,ix} Even at low levels encountered by the general public, dioxins and furans are known to increase the lifetime risk of cancer.^x According to the EPA, dioxins and furans are likely to cause cancer. Exposure also disrupts normal hormone levels in both animals and humans.^x Exposure to dioxin is associated with reproductive problems such as abnormal fetal development as well as immune system suppression in laboratory studies.^x

Dioxins and furans build up in the body over time, so concentrations will increase over a

firefighter's career. Once absorbed, they are difficult to remove from the body. In rescue workers receiving treatment to remove persistent chemicals from their bodies after the World Trade Center disaster, dioxins were only slightly reduced compared to other chemicals like PCBs.^{xi}

What can be Done?

Removing harmful chemicals such as brominated flame retardants and PVC from the market will help reduce exposures to dioxins and furans in firefighting.

ⁱ Lemieux PM, Lutes CC, Santoianni DA. 2004. Emissions of organic air toxics from open burning: a comprehensive review. *Progress in Energy and Combustion Science* 30:1–32

ⁱⁱ Nakao T, Aozasa O, Ohta S, Miyata H. 2002. Formation of dioxin analogs by open-air incineration of waste wood and by fire of buildings and houses concerning Hanshin Great Earthquake in Japan. *Chemosphere* 46:429–437.

ⁱⁱⁱ Edelman P, Osterloh J, Pirkle J, Caudill SP, Grainger J, Jones R, Blount B, Calafat A, Turner W, Feldman D, Baron S, Bernard B, Lushniak BD, Kelly K, Prezant D. 2003. Biomonitoring of chemical exposure among New York City firefighters responding to the World Trade Center fire and collapse. *Environ Health Persp* 111, 1906–1911.

^{iv} Theisen J, Funcke W, Balfanz E, König J. 1989. determination of pcdfs and pcdds in fire accidents and laboratory combustion tests involving pvc-containing materials. *Chemosphere*. 19(6):423-428,

^v McNeil IC, Memetea L, Cole WJ. 1995. A study of the products of PVC thermal degradation. *Polymer Degradation and Stability*. 49 :181-191

^{vi} Shin-ichi Sakai S, Watanabe J, Honda Y, Takatsuki H, Aoki I, Futamatsu M, Shiozaki K. 2001. Combustion of brominated flame retardants and behavior of its byproducts. *Chemosphere*. 42(5-7):519-531

^{vii} Chandra Jayakody, Dan Myers, Usman Sorathia, and Gordon L. Nelson. 2000. Fire-Retardant Characteristics of Water-Blown Molded Flexible Polyurethane Foam Materials. *J. Fire Sciences*. 18:430-455,

^{viii} Liem AKD, Furst P, Rappe C. 2000. Exposure of populations to dioxins and related compounds. *Food Additives and Contaminants*. 17(4):241-259

^{ix} EPA. 2009. Dioxin exposure initiative publications. Available:<http://cfpub.epa.gov/ncea/cfm/recorddisplay.cfm?deid=54886>

^x EPA. 2010. Persistent Bioaccumulative and Toxic Chemical Program: Dioxins and Furans. <http://www.epa.gov/pbt/pubs/dioxins.htm>

^{xi} Dahlgren J, Cecchini M, Takhar, Paepke O. 2007. Persistent organic pollutants in 9/11 world trade center rescue workers: Reduction following detoxification. *Chemosphere* 69:1320–1325