



Fire Fighter Carcinogenic Exposures

Fire fighters are exposed to a wide array of carcinogenic agents in the line of duty and have a higher incidence of cancer than the general public. These exposures occur during nearly all aspects of firefighting and include fire responses of all types, diesel exhaust from fire apparatus and circadian sleep disruption.

In particular, fires release many hazardous substances that can lead to exposures via inhalation, ingestion and dermal absorption. Chronic exposure to carcinogenic agents in the fire service, whether visible or not, puts fire fighters at a higher risk for developing cancer.

The International Agency for Research on Cancer (IARC) groups carcinogenic agents according to the strength of scientific evidence regarding whether or not an agent can cause cancer. IARC Group 1 carcinogenic agents are those for which there is sufficient scientific evidence that the agent can cause cancer. IARC Group 2A and 2B agents are probable and possible human carcinogens, respectively. Group 2A probable carcinogenic agents are those for which there is some evidence of carcinogenicity in humans, sufficient evidence of carcinogenicity in experimental animals or strong mechanistic evidence that the agent is carcinogenic to humans. Group 2B possible carcinogenic agents are those that only satisfy one of the criteria listed for Group 2A.

IARC GROUP 1 AGENTS (including but not limited to)	IARC GROUP 2A/B AGENTS (including but not limited to)
<ul style="list-style-type: none">• arsenic• asbestos• benzene• cadmium• 1,3-butadiene• diesel engine exhaust• benzo[a]pyrene• formaldehyde• polychlorinated biphenyls (PCBs)• silica• soot• vinyl chloride	<ul style="list-style-type: none">• polycyclic aromatic hydrocarbons (PAHs)• per/poly-fluoro alkyl substances (PFAS)• dioxins• creosote• products of biomass fuel combustion• shiftwork with circadian disruption

Exposures on the Fire Ground

A wide range of chemicals have been detected in smoke and soot during fire suppression and overhaul. These contaminants can be inhaled, ingested, and absorbed through the skin and will cover PPE and fire suppression equipment remaining there until washed off. This can lead to additional exposures if fire fighters remove their self-contained breathing apparatus (SCBA) at any time while on the fire ground. If they do not perform preliminary exposure reduction (on-scene, post fire decontamination, these contaminants can be brought in the apparatus' cab or back to the fire station.

Exposures in Fire Stationsⁱ

Many of the contaminants that fire fighters encounter during fire responses can be traced back to the fire stations where they live throughout their shifts when not responding to a call. In a study evaluating dust samples in 26 fire stations in the United States, researchers documented phosphorous-containing and polybrominated diphenyl ether flame retardant levels in fire stations were higher than those previously reported in homes and other occupational settings around the world. The study was replicated in Canada with the same findings.

Daily exposure to diesel exhaust in the firehouse can also contribute to the development of cancer. Analysis of the kitchen, bunkroom walls and furniture in firehouses reveal a tremendous amount of diesel exhaust particles. These dangerous particles are inhaled and absorbed every shift and cause significant harm to fire fighters.

Routes of Exposure

1. Inhalation Exposures

- Most common route of exposure for fire fighters
- Chemicals released in smoke and soot do not disappear when the fire is extinguished and remain airborne through all phases of fire activities
- Inhalation can also occur from various sources, including off-gassing from contaminated equipment and personal protective equipment (PPE) and diesel exhaust at the station

2. Dermal Exposures

- Dermal absorption occurs when contaminated particulates are absorbed through the skin
- Dermal absorption to carcinogens found in soot can occur even while wearing turnout gear when soot is transferred to the fire fighters' skin either during firefighting activities or while removing contaminated PPE
- Elevated temperatures have been associated with increased dermal absorption

3. Ingestion Exposures

- Less common route of exposure for fire fighters
- Soot is the typical exposure source as it transfers to fire fighters' hands and if not washed can be ingested through eating, drinking and putting hands in your mouth.
- A 2020 research study that evaluated chemicals in the air and on fire fighter ensembles identified that gloves are some of the most contaminatedⁱⁱ

ⁱ Shen B, Whitehead TP, Gill R, et al. Organophosphate flame retardants in dust collected from United States fire stations. *Environment International* 112 (2018) 41–48.

ⁱⁱ Kenneth W. Fent, Mark LaGuardia, Drew Luellen, Seth McCormick, Alexander Mayer, I-Chen Chen, Steve Kerber, Denise Smith, Gavin P. Horn. Flame retardants, dioxins, and furans in air and on firefighters' protective ensembles during controlled residential firefighting. *Environment International*, Volume 140, 2020.